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COMPREHENSIVE STUDY OF WATER AND RELATED LAND RESOURCES. PUGET --ETC(U)
MAR 70 A T NEALE, L F KEHNE, F L NELSON

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# Comprehensive Study of Water and Related Land Resources

# *Puget Sound and Adjacent Waters*

## State of Washington

## Appendix VII
## Irrigation



Puget Sound Task Force—Pacific Northwest River Basins Commission







March 1970

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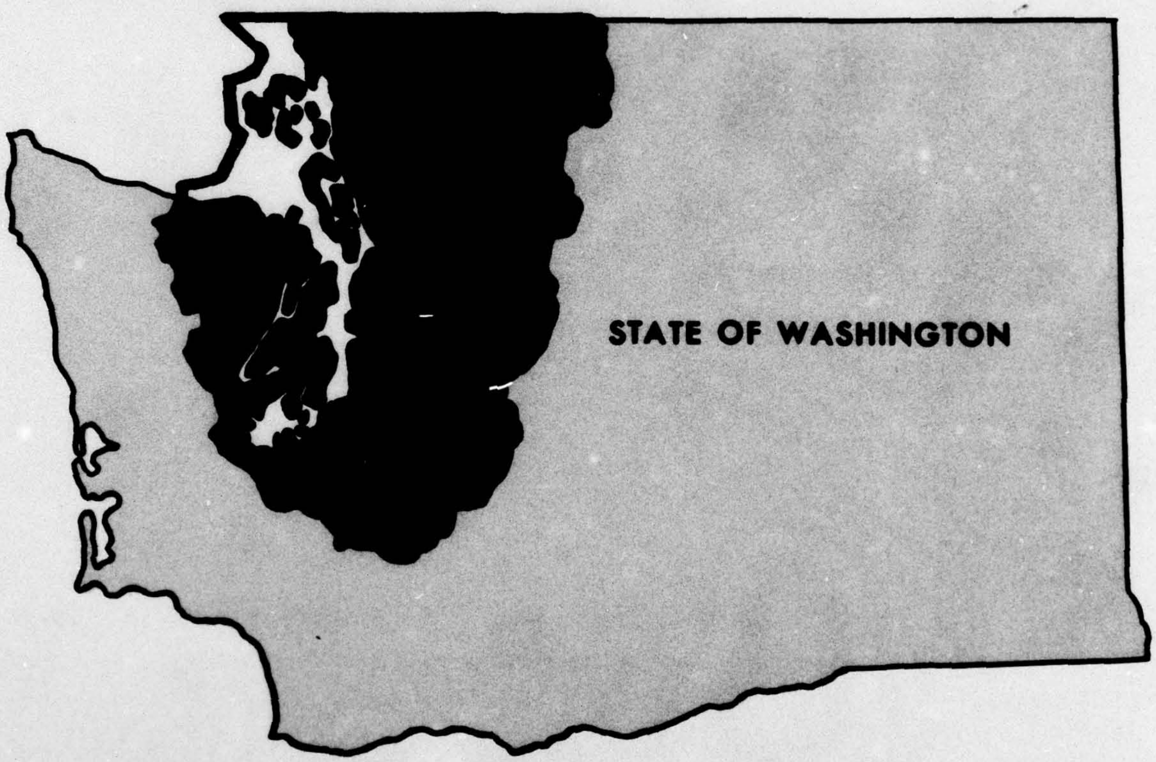


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# Comprehensive Study of Water and Related Land Resources.

# Puget Sound and Adjacent Waters.

## APPENDIX VII.

## IRRIGATION,

10

Alfred T. Neale, Sydney Steinborn, Lewis F. Kehne, Ernest E. Allen Francis L. Nelson



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**PUGET SOUND TASK FORCE of the PACIFIC NORTHWEST RIVER BASINS COMMISSION**

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# FOREWORD

APPENDIX VII, IRRIGATION, contains a detailed report of one component of the Comprehensive Water Resource Study of Puget Sound and Adjacent Waters. It is one of the technical appendices providing supporting data for the overall water resource study.

The Summary Report is supplemented by 15 appendices. Appendix I contains a Digest of Public Hearings. Appendices II through IV contain environmental studies. Appendices V through XIV each contain an inventory of present status, present and future needs, and the means to satisfy the needs, based upon a single use or control of water. Appendix XV contains the formulation of basin plans.

The purpose of this appendix is to: (1) appraise the extent of present irrigation development in the Puget Sound Area; (2) determine the potential for sustained irrigation development; and, (3) identify single-purpose means to meet the foreseeable short and long-term irrigation needs.

River-basin planning in the Pacific Northwest was started under the guidance of the Columbia Basin Inter-Agency Committee (CBIAC) and completed under the aegis of the Pacific Northwest River Basins Commission. A Task Force for Puget Sound and Adjacent Waters was established in 1964 by the CBIAC for the purpose of making a water resource study of the Puget Sound based upon guidelines set forth in Senate Document 97, 87th Congress, Second Session.

The Puget Sound Task Force consists of ten members, each representing a major State or Federal agency. All State and Federal agencies having some authority over, or interest in, the use of water resources are included in the organized planning effort.

The published report is contained in the following volumes.

## SUMMARY REPORT

## APPENDICES

I. *Digest of Public Hearings*
II. Political and Legislative Environment
III. Hydrology and Natural Environment
IV. Economic Environment
V. Water-Related Land Resources
  a. Agriculture
  b. Forests
  c. Minerals
  d. Intensive Land Use
  e. Future Land Use
VI. Municipal and Industrial Water Supply
VII. Irrigation
VIII. Navigation
IX. Power
X. Recreation
XI. Fish and Wildlife
XII. Flood Control
XIII. Water Quality Control
XIV. Watershed Management
XV. Plan Formulation

# APPENDIX VII
# IRRIGATION

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# INTRODUCTION

This is the Irrigation Appendix to the Comprehensive Water Resource Study Report of Puget Sound and Adjacent Waters. It presents material supporting the irrigation analyses and conclusions used in preparing the plans in the Main Report.

The plans in the Main Report have been developed to ensure the best means for meeting maximum possible future water needs through development of the natural resources. Although the Puget Sound river basins yield large quantities of high quality water, there is considerable variation in streamflow. There are high flows in the winter and spring and low flows through the summer. The rapid population and industrial expansion along the eastern side of Puget Sound have created an ever increasing year around demand for water. This, in turn, has intensified the need for long-range planning covering all water aspects.

Because of the geographic nature of the Puget Sound Area, agricultural lands are limited and those lying near expanding population centers, are increasingly being converted to industrial and urban uses. Farming on the remaining lands will require more intensive management to meet future production demands. One important way is through irrigation development. Significant private irrigation development has already taken place in several basins, especially since 1955. Future irrigation development will depend on availability of water. Thus, in any evaluation of the future water resource situation, it is necessary that irrigation needs be considered and provision made for irrigation development.

## IRRIGATION STUDY PROCEDURES

The irrigation study was prepared in three stages: (1) evaluation of present status of irrigation; (2) projection of future needs for irrigation; and (3) determination of means for meeting these irrigation needs.

### (1) Present Status

Evaluation of the lands, water use, and agricultural economics was made to determine the present status of irrigation.

Irrigated lands were identified during reconnaissance land classification field surveys and mapped on aerial photos.

Irrigation water use was estimated using the Blaney-Criddle procedure, recorded climatological data, and estimated field application losses and efficiencies. Water diversion measurements were not made.

Increased yields, and gross farm income attributable to irrigation were estimated from field interviews, published statistics and other available studies.

### (2) Projection of Future Needs

Future irrigation needs derive basically from: (a) the need for farmers to intensify their farm management to maintain an economical farm unit; and (b) the need for more food from a limited and decreasing land resource. It was assumed that the combination of decreasing agricultural lands and increasing demand for agricultural products in the Puget Sound Area would spur farm measures such as irrigation and drainage to increase farm production throughout the Area.

Projection of irrigation for years 1980, 2000, and 2020 followed four distinct steps.

The first step was to make a determination of the lands suitable for sustained irrigation. These lands were identified from reconnaissance land classification field surveys and mapped by basin.

The second step involved correlating the preliminary findings of other technical appendices. Incorporating data from these appendices provided a basis for identifying the lands that could be irrigated.

Unit water requirements for the irrigable lands in each basin were determined as step three.

Projecting the amount of future irrigation was the fourth step. Suitability of lands, availability of an adequate water supply, future needs, and historical trends were used to project the rate of future development.

### (3) Means to Satisfy Needs

The final phase of the study was a determination of the single-purpose means by which the lands projected to be irrigated could be met in each basin. The quantity of water available was estimated using the combined sources of the Hydrology and Natural

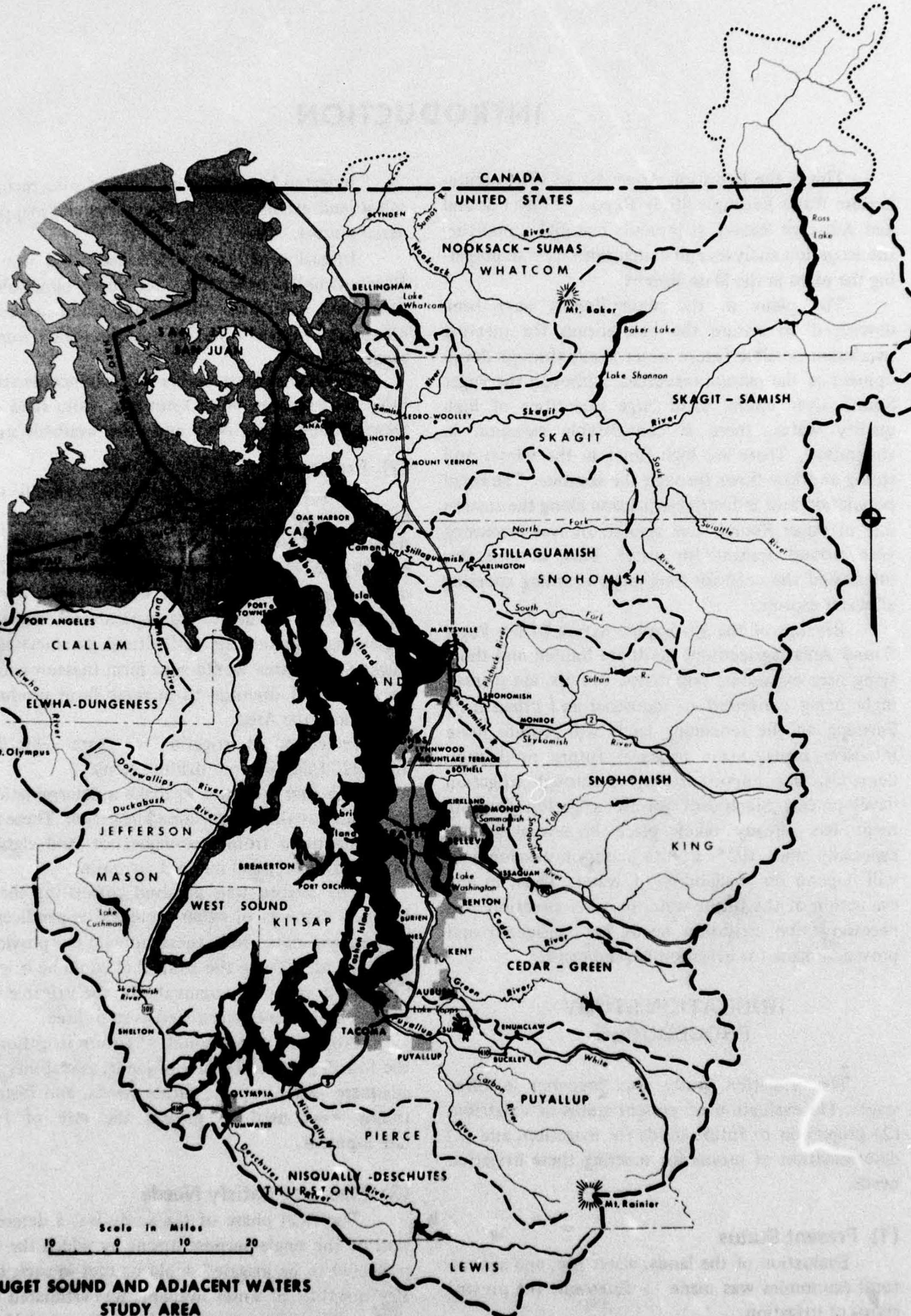



**FIGURE 1-1 Basins in the Puget Sound and Adjacent Waters Study Area**

Environment Appendix and water right tabulations. The most likely source of water supply to meet irrigation needs in each basin was identified. Costs were estimated for single-purpose means of furnishing a water supply to lands projected to be irrigated in each basin. Except for the Nooksack-Sumas, Skagit-Samish and Elwha-Dungeness Basins, these costs were based on average costs to provide private irrigation service only. They were derived by estimating average investment and annual operating costs for several representative areas in the Puget Sound Area, and applying them to individual basins. In the Nooksack-Sumas, Skagit-Samish and Elwha-Dungeness Basins, cost of providing irrigation service by project-type development were estimated.

The additional annual gross income values accruing to the farmers for irrigating his crops were determined.

Estimates of irrigation facility costs and additional gross income values associated with projected irrigation development were derived by the Bureau of Reclamation.

Engineering layouts made on available USGS topographic maps were considered adequate to give general cost relationships for this study.

## HISTORY OF IRRIGATION DEVELOPMENT

Agriculture in the Puget Sound Area started with the earliest settlement. The Puget Sound Agricultural Company, a subsidiary of the Hudson's Bay Company, grazed cattle and sheep on the tall grass prairies in Pierce County about 1843. During the 1850's, cattle and grain from the area were shipped by way of Alaska to Russia in exchange for furs. In most cases, agriculture was established to support logging, fishing, and mining industries. The farmlands first developed were usually on the stream-deltas and in the valleys because they were easier to clear, had better supply of moisture, and were more fertile.

The need for irrigation was apparent to the early farmers. Although annual rainfall in the area is high, summer precipitation is often inadequate for optimum crop growth. Available moisture from June through August averages about half the amount required for full crop production. Also, crop diversification is limited because of low summer precipitation.

In 1895, a group of farmers near Sequim organized a ditch company and constructed irrigation facilities to divert water from the Dungeness River. In this area of the Olympic Mountains rainshadow, annual precipitation is about the same as the semiarid regions of eastern Washington.

By 1910, four irrigation projects were in operation in the Puget Sound Area. They were the Sequim, Eureka, Yelm, and Independent ditches, and all were cooperative landowner enterprises. Also in the early 1900's, a few small tracts were being irrigated in Pierce, King, and Thurston counties. During the period 1900 to 1945, however, most irrigation remained concentrated in the Sequim and Yelm areas.

Since 1945, the irrigated acreage has increased significantly in many basins, and the largest growth has been in the Nooksack Valley. There are presently about 91,700 acres irrigated in the Puget Sound Area as compared to 10,300 in 1945, and 6,100 in 1919.

Technological advances, especially sprinkler application, have been responsible for much of the irrigation growth. Readily available water supply in the past was a significant factor in this growth because of ease of private development with sprinkler systems.

## PREVIOUS IRRIGATION STUDIES

There have been relatively few irrigation studies in the Puget Sound Area. The Washington State Extension Service prepared the following four reports based upon experiments at its Puyallup Experiment Station on crop yields, benefits, and costs of individual irrigation:

1935 "Pasture Irrigation" Bulletin No. 313.

1940 "An Economic Study of Farm Irrigation in Western Washington."

1941 "Irrigation, Western Washington."

1942 "Irrigating Western Washington Farms."

The Bureau of Reclamation has prepared the following six reports on potential irrigation project developments:

1941

At the suggestion of the Washington State Department of Conservation and Development, the potential of several possible irrigation developments in western Washington were briefly evaluated.

1942

The general economic aspects of the Green-Puyallup Project in King and Pierce Counties, in

relation to irrigation development, was studied.

1943

At the request of various organizations and the State congressional delegation, the possibility of using the flows of the Green and Puyallup Rivers for irrigation was investigated. Three alternatives for the Auburn Unit, based on storage for sprinkler irrigation, showed that the lands would be highly responsive to irrigation, but further studies were discontinued for lack of positive landowner interest.

1946

A reconnaissance report on the Sequim Project in Clallam County pointed up the need for a detailed investigation.

1951

A detailed investigation of the Sequim Project developed a feasible economic plan that would allow replacement, with a project pressure system, of a number of independent gravity distribution systems of questionable dependability and large water losses. No additional work was done on this project because of insufficient landowner interest.

1953

A reconnaissance investigation of the Yelm Project in Thurston County was made to determine land capability, sources and quantity of water supply, tentative determination of landowner payment capacity, and preliminary projections for development of the area. Project development lacked local support and no further studies were made.

## GLOSSARY

This glossary provides abbreviated definitions of technical terms used in this appendix. In general, terms having common dictionary definition or those for which a definition is provided as a part of the narrative discussion have not been included.

**Acid Soil**—A soil giving an acid reaction (precisely, below pH 7.0; practically, below pH 6.6) throughout most or all of the portion occupied by roots.

**Acre-Foot (ac-ft)**—A unit commonly used for measuring the volume of water or sediment; equal to the quantity of water required to cover one acre to a depth of one foot and equal to 43,560 cubic feet or 325,851 gallons.

**Alkaline Soil**—A soil with so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

**Alluvium**—Soil material, such as sand, silt, or clay, that has been deposited by water.

**Aquifer**—A rock formation, bed, or zone containing water that is available to wells. An aquifer may be referred to as a water-bearing formation or water-bearing bed.

**Arable Lands**—Lands which are delineated by classification procedure as suitable for irrigation development.

**Bottom Land**—Low land formed by alluvial deposits along a river or stream.

**Construction Cost**—The total cost of construction, including real estate, engineering, design, administration and supervision.

**Consumptive Use**—The quantity of water that is absorbed by the crop and transpired or used directly in the building of plant tissue, together with that evaporated from the cropped area.

**Cubic Feet Per Second (cfs)**—A unit expressing rate of discharge. One cubic foot per second is equal to the discharge of a stream having a cross section of one square foot and flowing at an average velocity of one foot per second. It also equals a rate of 448.8 gallons per minute.

**Depletion, Streamflow**—The amount of water that flows into a valley, or onto a particular land area, minus the water that flows out of the valley or off from the particular land area.

**Discharge**—In its simplest concept, discharge means outflow; therefore, the use of this term is not restricted as to course or location and it can be used to describe the flow of water from a pipe or a drainage basin.

**Diversion**—The taking of water from a stream or other body of water into a canal, pipe, or other conduit.

**Effective Precipitation**—That part of the precipitation falling on a crop area that is effective in meeting the consumptive use requirements of the crop.

**Farm Delivery Requirement**—The amount of water in acre-feet per acre required to serve a cropped area from a canal or pipe turnout. It is the crop irrigation requirement plus farm waste and deep percolation.

**Gaging Station**–A particular site on a stream, canal, lake or reservoir where systematic observations of gage height or discharge are obtained.

**Ground Water**–Water in the ground that is in the zone of saturation from which wells, springs and ground water runoff are supplied.

**Irrigated Land**–Land receiving water by controlled artificial means for agricultural purposes from surface or subsurface sources.

**Irrigation Conveyance Loss and Waste**–The loss of water in transit from a reservoir, point of diversion, or ground water pump (if not on farm) to the point of use, whether in natural channels or in artificial ones, such as canals, ditches, and laterals.

**Irrigation Depletion**–The amount of diverted water consumptively used, beneficially and nonbeneficially, in serving a cropped area. It is the gross diversion minus return flow.

**Irrigation Requirement, Crop**–The amount of irrigation water in acre-feet per acre required by the crop; it is the difference between crop consumptive use requirement and effective precipitation.

**Man-Year of Employment**–The amount of labor that would be accomplished by a full-time employee.

**Normally Irrigated Acreage**–Lands irrigated every year regardless of precipitation during the growing season.

**Normalized Value (Adjusted)**–Current prices, i.e., 1964 agricultural price data, that have the effects of abnormalities caused by weather, other short-term circumstances and direct government price support payments removed.

**Operation and Maintenance Costs**–Average annual costs of operation and normal maintenance of irrigation facilities.

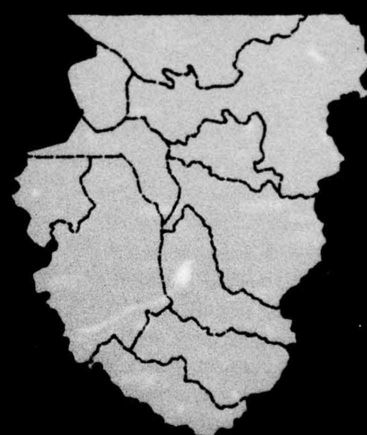
**Potentially Irrigable Land**–Land having soil, topography, drainage, and climatic conditions suitable for irrigation.

**Return Flow (Irrigation)**–Irrigation water applied to an area which is not consumed in evaporation or transpiration and returns to a surface stream or ground water aquifer.

**Runoff**–That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage or other works of man in or on the stream channels.

**Supplemental Irrigation**–When irrigation water supplies are obtained from more than one source, the source furnishing the initial supply is commonly designated the primary source, and the sources furnishing the additional supplies, the supplemental sources.

# Puget Sound Area



# THE PUGET SOUND AREA

## PRESENT STATUS

Since 1945, irrigation in the Puget Sound Area has shown marked growth. Bureau of Reclamation land classification surveys from 1963 to 1966 indicated there were about 91,700 acres irrigated in the area, as compared to 6,100 in 1919, and 10,300 in 1945.

The relatively uniform marine climate of the Puget Sound Area is suitable for growth of a variety of crops. Due to the moist climate, irrigation is primarily used to prevent total crop failure and to maintain plant growth rather than to produce optimum yields. Some special uses of irrigation, such as protection from frost and for seeding and transplanting are practiced in certain areas. Yields can be increased, and higher valued fruit, vegetable and specialty crops can be produced with irrigation.

Irrigated lands are generally in scattered small areas interspersed with larger areas of nonirrigated land. The suitability of irrigation is determined by soil characteristics, drainage, availability of water, and the type of system desired by the farm operator. There are abundant ground water and surface water sources in the Puget Sound Area, but a combination of all the factors involved has not encouraged development of large tracts for irrigation. Most of the lands presently irrigated have been developed through private means.

A notable exception to the general pattern of irrigated agriculture in the Puget Sound Area is the Sequim Area in the Elwha-Dungeness Basins. The semi-arid climate of this area, which is similar to that of eastern Washington, has resulted in extensive irrigation development. Irrigation districts and companies serve about 16,000 acres in this area.

A field survey of irrigation in the Puget Sound Area was made by the Bureau of Reclamation during the period 1963-1966. Location of irrigated lands was determined by field inspections and from interviews with local farmers. Some of the lands identified are not irrigated every year, and the number of acres irrigated in any one year depends on summer rainfall. Lands classified as irrigated include only those which received irrigation water during the year in which they were classified. Table 2-1 lists, by basins, the irrigated acreages determined from the field survey. The location of these irrigated lands are shown in Figure 2-1.

To determine the dollar value of irrigation it was necessary to estimate the number of acres irrigated in a year having average precipitation during the growing season. These average acreages are considered to be irrigated every year regardless of the precipitation. Estimates of the number of acres normally irrigated were based primarily upon the relationship between crop consumptive use and effective precipitation during the growing season. Table 2-1 shows the estimated number of acres considered to be normally irrigated in each basin.

**TABLE 2-1. Estimate of irrigation development by basins (1963-1966)**

| Basin | Maximum Irrigated Acreage (Acres) | Normally Irrigated Acreage (Acres) |
|---|---|---|
| Nooksack-Sumas | 38,400 | 17,000 |
| Skagit-Samish | 6,200 | 6,200 |
| Stillaguamish | 2,500 | 2,200 |
| Whidbey-Camano Islands | 2,700 | 900 |
| Snohomish | 12,800 | 12,800 |
| Cedar-Green | 2,600 | 2,600 |
| Puyallup | 3,700 | 3,700 |
| Nisqually-Deschutes | 5,600 | 5,600 |
| West Sound | 1,200 | 1,200 |
| Elwha-Dungeness | 15,900 | 15,900 |
| San Juan Islands | 100 | 100 |
| PUGET SOUND AREA | 91,700 | 68,200 |

## IRRIGATED LANDS

### Soils

Soils in the Puget Sound Area vary considerably in adaptability, management requirements, origin, texture and structure. With few exceptions, they range from strongly acid to slightly less than neutral and application of lime is recommended in many areas.

A part of the soils are either coarse textured, or have shallow depths to sand or gravel but with

irrigation and proper management relatively high yields can be produced.

More than one-half of the soils have restricted internal drainage caused by fine textured, slowly permeable soil, or cemented impervious or nearly impervious substrata. These soils hold adequate moisture from crop growth late into the growing season during average years but become very dry as the summer season progresses. In dry years, irrigation is necessary for maximum crop production on these lands.

### Topography

Topography of the irrigated lands varies from nearly level to strongly undulating. In the higher lying upland areas the lands are generally irrigated by sprinkler methods.

### Drainage

The soils in Puget Sound Area are leached of soluble minerals, and there is no danger of saline or alkali problems developing in the future, therefore, drainage need not be considered for removal of harmful accumulations of salts. However, a large part of the lands are in need of surface drains for removal of excess moisture in periods of heavy winter precipitation. In places, subsurface drainage is needed to lower the water table for improved crop production.

## LAND CLASSIFICATION

An economic land classification was made of the land resources to determine their suitability for sustained irrigation. An economic classification must necessarily take into consideration factors which relate to productivity, costs of land development, and costs of production. Sustained irrigation means that the area to be irrigated must continue to produce satisfactorily for an indefinite period of time.

An economic classification segregates lands which are suitable for irrigation into land classes in accordance with their relative suitability for irrigation development. Although the primary purpose is to delineate land into relative economic land classes which reflect potential productive capacity when irrigated, there are other uses as well. Data from this type of land classification is used in determining water requirements for different types of soil, percolation losses, irrigation efficiency, the method of irrigation, cropping pattern best suited to a particular area and drainage requirements with irrigation.

There are three land classes suitable for irrigation in the Puget Sound Area. Class I lands are the best lands, and are suited to a wide range of crops. They are capable of producing relatively high yields at reasonable cost. They are fertile or respond readily to fertilizer applications and are smooth lying with gentle slopes. The soils are deep and of medium to moderately fine texture with mellow, open structure allowing easy penetration of roots, air and water and having free drainage yet ample available moisture capacity. These soils are free from harmful accumulations of soluble salts. Farm drainage costs would be low. Minimum erosion will result from irrigation, and land development can be accomplished at relatively low cost.

Class 2 lands comprise areas of good suitability for irrigation farming, being measurably lower than Class 1 in productive capacity, adapted to a somewhat narrower range of crops, more expensive to prepare for irrigation or more costly to farm. They are not so desirable nor of such high value as lands of Class 1 because of certain correctable or noncorrectable limitations. They may have a lower available moisture capacity, as indicated by coarse texture or limited soil depth; they may be only slowly permeable to water because of clay layers or compaction in the subsoil. Topographic limitations include uneven or rolling surface relief, or steeper slopes necessitating special care and greater costs to irrigate and prevent erosion. Farm drainage may be required at a moderate cost. Any one of these limitations may be sufficient to reduce lands from Class 1 to Class 2 but frequently a combination of two or more of these factors exists.

Class 3 lands have more pronounced deficiencies in soil, topographic, or drainage characteristics than Class 2 lands. They may have good topography but because of inferior soils have restricted crop adaptability, require larger amounts of irrigation water or special irrigation practices and may need heavy fertilization or more extensive soil improvement practices. They may have uneven or steep topography. Generally, greater economic risk may be involved in farming Class 3 lands than higher classes of land, but under proper management they are expected to be suitable for irrigation development.

The land classes of the irrigated lands in the Puget Sound Area are shown in Table 2-2.

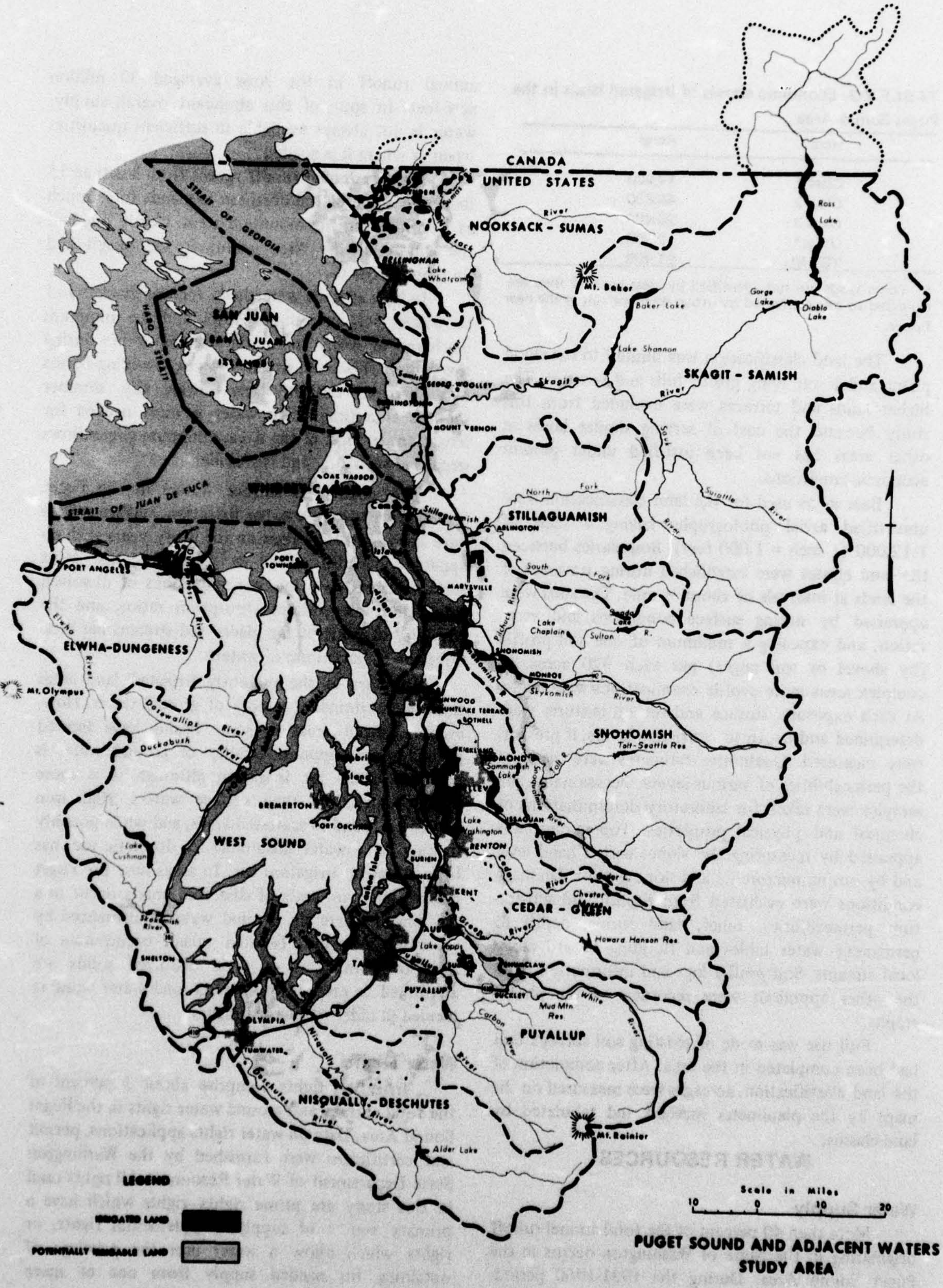



**FIGURE 2-1 Irrigation in the Puget Sound and Adjacent Waters Study Area**

**TABLE 2-2. Economic classes of irrigated lands in the Puget Sound Area**

| Item | Acres |
|---|---|
| Class 1 | 14,200 |
| Class 2 | 48,800 |
| Class 3 | 26,400 |
| Other* | 2,300 |
| TOTAL | 91,700 |

* These lands are not identified by class because they are expected to be supplanted by urban development in the near future.

The land classification was limited to the flood plains and lower lying glacial hills and terraces. The higher lands and terraces were excluded from this study because the cost of serving similar lands in other areas has not been justified under present economic conditions.

Base maps used for the land classification were unrectified aerial photographs having a scale of 1:12,000 (1 inch = 1,000 feet). Boundaries between the land classes were established during traverses of the lands at intervals of about ½ mile. The soils were appraised by noting surface conditions and vegetation, and exposing a minimum of one soil profile (by shovel or soil auger) per each 320 acres. In complex areas more profile examinations were made. At each exposure, surface and subsoil textures were determined and depth to restrictive layers, if present, were measured. Qualitative estimates were made of the permeabilities of various layers. Occasionally, soil samples were taken for laboratory determinations of chemical and physical properties. Topography was appraised by measuring the slopes with a hand level and by noting microrelief and slope aspects. Drainage conditions were evaluated from topsoil and substratum permeabilities, relief, land forms, depth to permanent water tables and flooding hazard along local streams. Soil profile logs and information from the other appraisals were recorded on the photographs.

Full use was made of existing soil surveys that had been completed in the area. After completion of the land classification, acreages were measured on the maps by the planimeter method and tabulated by land classes.

## WATER RESOURCES

### Water Supply

More than 40 percent of the total annual runoff originating in the State of Washington occurs in the Puget Sound Area. During the 1931-1960 period, annual runoff in the Area averaged 39 million acre-feet. In spite of this abundant overall supply, water is not always available in sufficient quantities when or where it is needed.

Average annual runoff ranges from less than 15 inches in some of the northern lowlands to as much as 140 inches in the mountain areas. Nearly one-half the runoff of the Area occurs in the Skagit and Snohomish Basins.

In high altitude watersheds, melting glaciers and snowfields sustain summer flows, and the minimum discharge of many mountain streams occurs during the winter. However, streamflows in low-lying basins may become critically low during dry summer months at a time when water is most needed for irrigation. In most of the Area, minimum streamflows occur between July and November.

The quality of surface waters in the Puget Sound Area is excellent for irrigation; surface waters have been used for irrigation for many years with no apparent harmful effect to soils or crops. Most surface waters have low concentrations of dissolved solids and low sodium absorption ratios, and the turbidity of some of the glacial fed streams has little effect on irrigation use of waters.

In most of the presently irrigated land areas there is an abundant supply of ground water. However, localized areas in some basins have limited ground-water supplies. Quality of ground water is generally good for irrigation although it is more highly mineralized than surface waters. High iron content is found in scattered areas, and while possibly making some water unsuitable for domestic use, has little effect on irrigation use. In areas near the Puget Sound, large amounts of dissolved solids occur in a few places where the ground water is influenced by sea-water intrusion. Isolated inland occurrences of high concentrations of total dissolved solids are attributed to production from ground water aquifers located in older marine sediments.

### Water Rights

Irrigation rights comprise about 3 percent of the total surface and ground water rights in the Puget Sound Area. Data on water rights applications, permit and certificates were furnished by the Washington State Department of Water Resources. All rights used in this study are prime rights–rights which have a primary source of supply. Supplemental rights, or rights which allow a water user the privilege of obtaining his needed supply from one or more

additional or alternate sources, are not included. There are relatively few supplemental rights in the Area and in most cases the water right quantities and acreages for these rights are duplicated in the prime right totals.

As of April 30, 1967, there were about 94,500 acres of land having permits or certificates for a surface water right. The total diversion to serve this acreage along with combined rights for stock and domestic water, is about 1,290 cubic feet per second.

Ground-water rights for irrigation as of September 30, 1966, totaled about 513 cubic feet per second for about 39,200 acres.

### Irrigation Water Requirements

The determination of irrigation water requirements was based on consideration of several factors including temperature, effective precipitation, soil characteristics, cropping practices, crop consumptive use, farm efficiency in application of irrigation water, and distribution system losses and waste. Requirements for each basin in the Puget Sound Area were estimated using the Blaney-Criddle procedure, and recorded climatological data for a five-year period constituting a critically-dry period.

Crop consumptive use is the quantity of water absorbed by plants, together with that evaporated from the cropped area. A part of the crop consumptive use is met by precipitation falling in the area during the growing season, and soil moisture remaining from precipitation during the nongrowing season. The difference between the crop consumptive use requirement and the effective precipitation and soil moisture must be provided through irrigation for maximum crop production, and is referred to as the "crop irrigation requirement."

The farm delivery requirement is the amount of water that is required at the farm headgate to supply the crop irrigation requirement and allow for farm losses and deep percolation. The farm delivery requirement is estimated by applying a farm efficiency to the crop irrigation requirement. The farm efficiency accounts for evaporation from sprinkler systems, surface runoff, and deep percolation.

Farm irrigation efficiency and the resulting farm delivery requirement depends to a large extent upon the farming practices of an individual farmer. Farm irrigation efficiencies used range from 60 to 65 percent. Peak farm delivery requirements, used to size irrigation systems, are estimated according to the Shockley and Woodward procedure.

To provide the required amount of irrigation water at the farm, an allowance must be made for distribution system losses and operational waste. Average distribution system losses and operational waste is estimated to be 5 percent of the diverted amount in areas served by pumping from ground water or from natural streams into farm sprinkler systems. Project-type distribution systems have similar losses, also averaging about 5 percent of the diverted amount.

Return flow due to irrigation includes distribution losses, farm losses and operational waste. A portion of the return flow resulting from irrigation is lost to nonbeneficial consumptive use. Depending on factors such as physical makeup of the basin or geographical relationship of the irrigated lands to the river or ground water source, another portion may not return to the stream channels or ground water sources. For example, the return flow in a river delta area may all travel directly into the ocean with the exception of a small amount that may be intercepted for use on the delta. The return flow, if it returns to the river, will partially offset the amount diverted from the river. The difference in the amount of water diverted and the usable net return flow is considered to be the depletion of the ground or surface source. Table 2-3 shows the seasonal irrigation requirements for each basin and the estimated depletion of ground and surface waters. Peak farm delivery requirements are also listed in Table 2-3.

## IRRIGATION ECONOMY

The effects of irrigation on the agricultural economy of the area have been evaluated in terms of additional gross farm income. This increment is summarized in Table 2-4 by basin and source of income. Data for the table is derived in the individual basin sections of this study. The figures in Table 2-4 represent the gross farm dollar value of increased crop and associated livestock and products sold in a normal rainfall year attributable to irrigation.

For purposes of comparison, the total dollar value of crops and associated livestock and production raised on irrigated land and the total dollar value of farm products sold in the Puget Sound Area were also included in Table 2-4. The total value of crops and associated livestock production raised on irrigated land represents the estimated value of increased production due to irrigation plus the value of production that would occur without irrigation. The value of farm products sold in the Puget Sound Area is the estimated value of production from all irrigated and nonirrigated land. The value of farm products

sold in the Puget Sound Area was estimated from 1964 Census of Agriculture material. In addition to this, Statistical Reporting Service data and field survey information were used to estimate production and value of crops and associated livestock produced on irrigated land. All values are on a current normalized basis.

## Irrigation Values

Only those irrigated crops used for human and livestock consumption were evaluated in arriving at a dollar value.

There are impacts from irrigation for which no dollar value has been derived because the detail involved in such a derivation exceeds the scope of this study. Examples of these are:

1. **Improved quality of grade**—Growers often receive a better price for irrigated crops, particularly vegetables, because their increased yields have a larger percentage of the better market grades.

2. **Reduced risk**—In a dry growing season such as occurred in 1967, irrigation is insurance against drastically reduced yields or crop failure.

3. **Crop diversification**—Irrigation permits land use in accordance with its capability. The hazard of growing crops such as mint, for example, is too great without an assured supply of moisture during the growing season.

4. **Improved crop stands**—Irrigation assures a high survival percentage of transplanted crops and germination of new seedings.

5. **Other values**—are associated with irrigation

**TABLE 2-3. Irrigation requirements by basins (acre-feet per acre)**

| Basin | Cons. Use | Crop Irr. Req. | Farm Del. Req. | Div. Req. | Return Flow | Depletion | Peak Farm Delivery Req. (Ac/cfs) |
|---|---|---|---|---|---|---|---|
| Nooksack-Sumas | 1.85 | 1.14 | 1.81 | 1.91 | 0.62 | 1.29 | 79 |
| Skagit-Samish | 1.93 | 1.18 | 1.82 | 1.92 | 0.06 | 1.86 | 79 |
| Stillaguamish | 2.18 | 1.18 | 1.82 | 1.92 | 0.59 | 1.33 | 79 |
| Whidbey-Camano Islands | 2.21 | 1.56 | 2.60 | 2.74 | * | 2.74 | 70 |
| Snohomish | 1.98 | 1.18 | 1.82 | 1.92 | 0.59 | 1.33 | 77 |
| Cedar-Green | 1.97 | 1.28 | 2.04 | 2.15 | 0.70 | 1.45 | 73 |
| Puyallup | 2.24 | 1.35 | 2.25 | 2.37 | 0.82 | 1.55 | 69 |
| Nisqually-Deschutes | 2.24 | 1.35 | 2.25 | 2.37 | 0.82 | 1.55 | 68 |
| West Sound | 2.22 | 1.45 | 2.42 | 2.55 | 0.79 | 1.76 | 69 |
| Elwha-Dungeness | 2.21 | 1.56 | 2.60 | 4.73 | * | 4.73 | 70 |
| San Juan Islands | 1.93 | 1.18 | 1.82 | 1.92 | * | 1.92 | 70 |

**TABLE 2-4. Incremental value of farm products sold related to normal irrigation use—1964**

| Basins | Crops | Associated Livestock and Products | Total |
|---|---|---|---|
| Nooksack-Sumas | $ 869,000 | $ 761,000 | $ 1,630,000 |
| Skagit-Samish | 199,000 | 219,000 | 418,000 |
| Stillaguamish | 10,000 | 148,000 | 158,000 |
| Whidbey-Camano Islands | | 46,000 | 46,000 |
| Snohomish | 114,000 | 779,000 | 893,000 |
| Cedar-Green | 530,000 | 49,000 | 579,000 |
| Puyallup | 338,000 | 155,000 | 493,000 |
| Nisqually-Deschutes | 148,000 | 302,000 | 450,000 |
| West Sound | 136,000 | 51,000 | 187,000 |
| Elwha-Dungeness | 170,000 | 1,259,000 | 1,429,000 |
| San Juan Islands | | 3,000 | 3,000 |
| Value of Increased Production | 2,514,000 | 3,772,000 | 6,286,000 |
| Value of Irrigated Land Production—Total | 7,933,000 | 9,626,000 | 17,559,000 |
| Value of Farm Products Sold—Puget Sound Area—Total | $18,566,000 | $62,891,000 | $81,271,000 |

*Negligible

of nursery stock, flower bulbs, cut flowers, and flower and vegetable seed crops. Irrigation has also been used on a limited basis for frost control.

## Basic Data

Agricultural Census data for 1964, and field survey information, have been used as a basis for estimating cropping patterns, farm types, and sizes, number of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect basin boundaries.

A study of land use in 1966 and 1967 was made by the Soil Conservation Service for each county in the Area. Identified cropland in each county was tabulated by basin, and grouped into cropland used for forage crops and that used for non-forage crop production.

In estimating the number of farms by type for each basin, the 1964 Census figures for each county were adjusted using the percentages developed in the Soil Conservation Service study. Dairy and other livestock farms were adjusted using the percentages for forage cropland. All others, with the exception of "General Farms," were adjusted using the nonforage cropland percentages. "General Farms" were assumed to have both forage and nonforage cropland, and an average percentage was used.

Table 2-5 shows the percentages used in adjusting county data to the basins.

**TABLE 2-5. Percent of the county land use prorated to the basins[1]**

| County | Basins | Forage Cropland (Percent) | Non-Forage Cropland (Percent) | Average (Percent) |
|---|---|---|---|---|
| Whatcom | Nooksack-Sumas | 99 | 100 | 99.5 |
| | Skagit-Samish | 1 | 0 | .5 |
| Skagit | Skagit-Samish | 100 | 99 | 99.5 |
| | Stillaguamish | 0 | 1 | .5 |
| Snohomish | Skagit-Samish | 3 | 4 | 3.5 |
| | Stillaguamish | 37 | 38 | 37.5 |
| | Snohomish | 57 | 58 | 57.5 |
| | Cedar-Green | 3 | 0 | 1.5 |
| King | Snohomish | 22 | 22 | 22 |
| | Cedar-Green | 61 | 66 | 63.5 |
| | Puyallup | 13 | 1 | 7 |
| | West Sound | 4 | 11 | 7.5 |
| Pierce | Puyallup | 44 | 97 | 70.5 |
| | Nisqually-Deschutes | 45 | 2 | 23.5 |
| | West Sound | 11 | 1 | 6 |
| Thurston[2] | Nisqually-Deschutes | 94 | 96 | 95 |
| | West Sound | 6 | 4 | 5 |
| Clallam[3] | West Sound | 17 | 2 | 9.5 |
| | Elwha-Dungeness | 83 | 98 | 90.5 |
| Mason | West Sound | 100 | 100 | 100 |
| Kitsap | West Sound | 100 | 100 | 100 |
| Jefferson[3] | West Sound | 100 | 100 | 100 |

[1] Based on U.S. Soil Conservation Service, "Land Use and Ownerships Summaries by Watershed and Study Area in the Puget Sound Area".

[2] About 60 percent of the county is in the Study Area, and only this amount of the census data for the county was credited to the Study Area.

[3] All of the agricultural lands and livestock in the county were assumed to be in the Study Area. Most of the county outside the Study Area is in National Parks, Forest or Indian Reservations.

## Types of Farms

There are about 14,000 farms in the Puget Sound Area, of which 1,100 or nearly 8 percent had irrigated cropland in 1964. The total number of farms in the area are identified by "farm type" in Table 2-6.

Farms are classified by the Census of Agriculture according to the major source of income from farm product sales, e.g., a poultry farm is one for which 50 percent or more of the farm income comes from the sale of poultry. Farms classified by products sold are "field crop," "vegetable," "fruit and nut," "poultry," "dairy," and "other livestock." Farms are classified as General and Miscellaneous if income is derived from sources other than those listed or if sales fall within three or more categories with no one source providing a majority. Miscellaneous farms include institutional, part-time and part-retirement farms and those selling nursery, greenhouse and forest products.

## Crops

A summary of acres normally irrigated and total acres harvested by crops is shown in Table 2-7.

## Land Use

The acreage irrigated in the Puget Sound Area varies considerably from basin to basin and is dependent, to a large extent, on the amount of rainfall occurring during the growing season. Some farmers with irrigation facilities may irrigate only a few years out of ten depending upon precipitation. Since there are few records available which disclose the extent of irrigation for every year, Agricultural Census and field observations data were relied upon to determine the acreage presently irrigated.

The latest Agricultural Census information available on acreage irrigated was from the 1964 survey. However, precipitation for that year was above normal during the growing season in all but one of the basins in the Puget Sound Area. U.S. Weather Bureau records show rainfall ranged from 120 to 180 percent of normal during the growing season in that year; the only exception was the Nisqually-Deschutes Basins where it was 103 percent of normal. Under

**TABLE 2-6. Number of farms by type in the Puget Sound Area—1964** [1]

| Type of Farm | Estimated Number in Area | Percent of Total |
|---|---|---|
| Field Crop | 50 | 0.4 |
| Vegetable | 280 | 2.0 |
| Fruit and Nut | 560 | 4.0 |
| Poultry | 520 | 3.7 |
| Dairy | 2,420 | 17.3 |
| Other Livestock | 1,250 | 8.9 |
| General | 230 | 1.6 |
| Miscellaneous | 8,690 | 62.1 |
| *Total* | 14,000 | 100.0 |

[1] Estimated from Census of Agriculture.

**PHOTO 2-1. Irrigation contributes to high-quality potato production in the Nooksack-Sumas Basins. The Basins are the prime producers of seed potatoes in the State. (USBR photo)**

these conditions, Census information for 1964 could not be used in evaluating the economic impact of irrigation in an average year.

At the time field observations were made of acreages being irrigated, growing season precipitation in some basins was below normal. Consequently, in these basins a correlation between Agricultural Census information and field observation was made to determine an acreage which was considered to be normally irrigated. The resulting acreage was used in the economic evaluation. Table 2-8 summarizes agricultural land use and cropland normally irrigated by basins.

The overall cropping pattern for each basin was then developed from county information reported in 1964 by the Census of Agriculture and where available County Horticultural Inspector's Reports. Agricultural technicians, food processors and others familiar with the local agricultural situation were interviewed in each basin. Based on these interviews and field observations, the acreages listed for each county in 1964 for crops other than hay and pasture were allocated among the basins. For example, the consensus of interview data concerning cropping pattern was that about one-third of the strawberries in Snohomish County are grown in the Stillaguamish Basin. The 1964 Agricultural Census reported 556 acres of strawberries in the county and the Horticultural Inspector's Report lists 700. The average of the two is 630 acres. The Stillaguamish Basin's share of this acreage was estimated to be 210 acres.

**TABLE 2-7. Estimated acres of crops harvested and acres normally irrigated in the Puget Sound Area—1964**

| Crops by Group | Acres Normally Irrigated[1] | Percent of Acres Normally Irrigated | Estimated Acres Harvested[2] | Percent of Crop Group Irrigated |
|---|---|---|---|---|
| **Small Grains** | 360 | 0.5 | 10,670 | 3.4 |
| **Field Crops** | 2,740 | 4.0 | 4,380 | 62.6 |
| Mint | (630) | | (630) | |
| Peas, Dry | (210) | | (660) | |
| Potatoes | (1,900) | | (3,090) | |
| **Forages** | 57,500 | 84.3 | 375,850 | 15.3 |
| Grass-Clover for Dehydrating | (1,000) | | (1,000) | |
| Hay | (25,440) | | (169,070) | |
| Pasture, Cropland | (30,780) | | (198,070) | |
| Silage, Corn | (280) | | (7,710) | |
| **Vegetables** | 4,230 | 6.2 | 42,370 | 10.0 |
| Beans, Snap | (930) | | (1,400) | |
| Beets | (60) | | (60) | |
| Broccoli | (100) | | (570) | |
| Cabbage | (310) | | (620) | |
| Carrots | (120) | | (180) | |
| Cauliflower | (170) | | (750) | |
| Celery | (240) | | (240) | |
| Corn, Sweet | (1,130) | | (7,300) | |
| Cucumbers | (270) | | (1,060) | |
| Lettuce, Fall | (480) | | (510) | |
| Peas, Green | (260) | | (23,380) | |
| Rhubarb | (160) | | (1,300) | |
| **Berries** | 3,370 | 5.0 | 8,830 | 38.2 |
| Blackberries | (80) | | (370) | |
| Blueberries | (200) | | (540) | |
| Raspberries | (1,210) | | (2,600) | |
| Strawberries | (1,880) | | (5,320) | |
| **Total or Average** | 68,200 | 100.0 | 443,100 | 15.4 |

1 Summarized from individual basin sections.

2 Estimated from Census of Agriculture and Horticultural Inspectors data.

The steps used to derive the irrigated cropping pattern for each basin were as follows:

1. Interview information from agricultural technicians, farmers and food processors was used to determine the number of years irrigation normally was used on all crops and the portion of each crop, other than pasture and hay, that was usually irrigated.

2. The portion of each crop irrigated, other than hay and pasture, was applied to the basin acreage for that crop to obtain the acres irrigated.

3. The acres irrigated were discounted for those years when irrigation was not used. The discount factor used was based on the weighted average number of years that irrigation was used. For example, about 25 percent of the 210 acres of strawberries in the Stillaguamish Basin were irrigated in those seasons when irrigation was used. However, irrigation is used for strawberries only 32 percent of the time. Thus, 210 acres x 25% x 32% = 20 acres of strawberries normally irrigated in the Stillaguamish Basin.

4. Pasture and hay crops were assumed to be grown on the remainder of the cropland normally irrigated and not accounted for by other crops. The ratio between the acres of irrigated hay and irrigated pasture was assumed to be the same as that for total hay and total pasture acreage for the counties in which the basins are located. For example, in the Nooksack-Sumas Basins, small grains, field crops, vegetables, berries and corn silage were grown on 4,930 of the 17,000 acres normally irrigated. Irrigated hay and pasture crops were grown on the remaining 12,070 acres. In 1964, about 45 percent of the total cropland used for hay and pasture crops in Whatcom County was used for pasture. Therefore, it was assumed that irrigated pasture crops are grown on 45 percent of the 12,070 acres.

**Yields**—Interviews were conducted in each basin to determine increased crop production realized from irrigation under normal weather conditions. These increased yields were applied to the acreage of crops normally irrigated to derive the crop production attributable to irrigation.

**Values**—The prices used to determine crop values were those received by farmers. These prices are on an adjusted normalized basis, i.e., an all-product index of 233 for prices received adjusted to remove direct price supports, 1910-14=100. This price level removes abnormalities caused by weather and other short-term circumstances and utilizes the most recent available price data. The Interdepartmental Staff Committee of the U.S. Water Resources Council has approved and recommended this price level for use in studies evaluating water resources.

All crops raised on irrigated land were valued using the gross crop values mentioned above except for those in the forage and small grain categories. Nearly all of the irrigated forages and small grains raised in the Puget Sound Area are used on the farm where they are produced, and are an integral part of the livestock operation. If all other factors of production remain the same, the capability of an area to support a livestock industry would be reduced without irrigated feeds. Therefore, the impact of

**TABLE 2-8. Summary of agricultural land use and cropland normally irrigated by basins and area[1]**

| Basins | Cropland (Acres) | Rangeland (Acres) | Forest (Acres) | Total Agricultural Acreage (Acres) | Cropland Normally Irrigated (Acres) | Cropland Percent Normally Irrigated (Acres) |
|---|---|---|---|---|---|---|
| Nooksack-Sumas | 137,000 | 12,000 | 609,000 | 758,000 | 17,000 | 12.4 |
| Skagit-Samish | 100,000 | 20,000 | 1,754,000 | 1,874,000 | 6,200 | 6.2 |
| Stillaguamish | 35,000 | 1,000 | 384,000 | 420,000 | 2,200 | 6.3 |
| Whidbey-Camano Islands | 23,000 | 2,000 | 85,000 | 110,000 | 900 | 3.9 |
| Snohomish | 72,000 | 2,000 | 1,055,000 | 1,129,000 | 12,800 | 17.8 |
| Cedar-Green | 53,000 | 3,000 | 447,000 | 503,000 | 2,600 | 4.9 |
| Puyallup | 37,000 | 6,000 | 593,000 | 636,000 | 3,700 | 10.0 |
| Nisqually-Deschutes | 45,000 | 43,000 | 508,000 | 596,000 | 5,600 | 12.4 |
| West Sound | 46,000 | 5,000 | 1,124,000 | 1,175,000 | 1,200 | 2.6 |
| Elwha-Dungeness | 24,000 | 2,000 | 409,000 | 435,000 | 15,900 | 66.2 |
| San Juan Island | 19,000 | 9,000 | 72,000 | 100,000 | 100 | 0.5 |
| Puget Sound Area | 591,000 | 105,000 | 7,040,000 | 7,736,000 | 68,200 | 11.5 |

[1] Summarized from individual basin sections.

these crops was evaluated in terms of their effect on the area's livestock industry rather than evaluating them in terms of gross crop values.

## Livestock

The livestock industry is a major consumer of the products of irrigated land and must be considered in an analysis of land and water resources use.

Cattle were the only livestock evaluated because:

1. Poultry generally do not consume irrigated feeds produced in the basins. Most small grains produced are for cattle feed.
2. Sheep and swine are relatively unimportant in the agricultural economy of most basins studied, and consume only minor amounts of feeds produced by irrigation.

**Irrigated Feeds**–The use of irrigated feeds may not affect the production of an individual animal; however, it does affect the total production of livestock and livestock products in a given area. If farmers in an area did not have access to irrigated feeds, they would either have to import feed or cut back on the number of livestock raised. Other factors such as feed produced on nonirrigated land and drugs for disease control, contribute to the total production of livestock and livestock products. However, in this study of irrigation use as related to the livestock industry, irrigated feeds represent the principal input to be considered.

**Feed Requirements**–The effect of irrigation on livestock enterprises was evaluated by comparing the feed requirements of cattle in a basin with feed *production attributable to irrigation in that basin.* The comparison was made in terms of "animal unit equivalents" (A.U.'s). An "animal unit equivalent" is approximately the amount of feed required per year for a 1,000 pound beef cow with calf by her side during a 6 month period. This is a unit of measure common to both feed requirements and production. One animal unit in this study is equal to 5,110 pounds of "total digestible nutrients" (T.D.N.) a year.

In estimating the A.U.'s of irrigated feed produced, hay was assumed to have 1,000 pounds T.D.N. per ton, an "animal unit month" of pasture 425 pounds of T.D.N., small grain 1,500 pounds of T.D.N. and silage 360 pounds of T.D.N. per ton.

PHOTO 2-2. The livestock industry is a major consumer of the products of irrigated land in the Puget Sound Area. (USBR photo)

Feed requirements are stated for four classes of cattle; dairy and beef cows, and dairy and beef feeders. Feed requirements listed for dairy and beef feeders are on a per head basis. Dairy and beef cow requirements include feed for bulls and replacement stock. The number of bulls and replacements needed were based on the number required per 100 cows.

For each 100 cows, the following number of other stock was assumed in figuring feed requirements:

| Dairy Cattle | | Beef Cattle | |
|---|---|---|---|
| Heifers | 20.0 | Heifers | 15.7 |
| Heifer calves | 23.3 | Heifer calves | 17.1 |
| Bulls[1] | 2.0 | Bulls | 4.0 |
| Bull yearlings | 0.6 | Bull yearlings | 1.1 |
| Bull Calves | 0.7 | Bull calves | 1.2 |

[1] Artificial insemination assumed for 50 cows.

Table 2-9 summarized feed requirements based on the above and the increased feed production related to irrigation use.

**Livestock Numbers.** Cattle numbers used in deriving basin feed requirements were based on 1964 Census of Agriculture information. Census figures were adjusted on the basis of a county's shore of forage cropland in each basin.

Dairy feeders were assumed to be equal to the allocated number of cattle in a basin less cows, less bulls and replacement stock and less the number of cattle fattened on grain and concentrate.

Beef feeders were assumed to be equal to the number of cattle fattened on grain and concentrate in the basin plus the number of farm slaughtered beef. Farm slaughtered beef is assumed to be 1.5 head per farm reporting cattle in the basin.

The number of head used in determining feed requirements and production differs from the number used in estimating production of livestock and livestock products related to irrigation. The latter number includes all cattle in the basins, while the number shown under feed requirements does not include bulls or replacement stock.

### Livestock and Livestock Product Values

Census data for 1964 was used in estimating sale values of livestock and livestock products related to irrigation. An adjustment of the data was made on the basis of a basin's share of the county's forage cropland as described in the preceding "Basic Data" section. Adjusted sales have been converted to the adjusted normalized price level discussed earlier in the "Irrigation Values" section so that all dollar values used in the study are on the same basis.

**TABLE 2-9. Summary of estimated feed production related to irrigation and feed requirements by basins[1]**

| Basins | Animal Units of Feed Required | Animal Units of Feed Produced | Percent Supplied by Irrigated Feed |
|---|---|---|---|
| Nooksack-Sumas | 71,700 | 3,200 | 4.5 |
| Skagit-Samish | 42,600 | 900 | 2.1 |
| Stillaguamish | 16,500 | 600 | 3.6 |
| Whidbey-Camano Islands | 6,200 | 300 | 4.8 |
| Snohomish | 34,800 | 3,100 | 8.9 |
| Cedar-Green | 27,400 | 200 | 0.7 |
| Puyallup | 19,000 | 700 | 3.7 |
| Nisqually-Deschutes | 26,200 | 1,700 | 6.5 |
| West Sound | 21,400 | 300 | 1.4 |
| Elwha-Dungeness | 12,800 | 7,900 | 61.7 |
| San Juan Islands | 2,380 | 40 | 1.7 |

[1]Summarized from individual basin sections.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Puget Sound Area total 516,000 acres, of which 91,700 are presently irrigated and 424,300 are potentially irrigable. Most of the potentially irrigable lands are located on the flood plains of the rivers which flow into the Puget Sound and on the intermediate terraces and upland glacial hills along the river valleys. It is expected that a total of about 223,000 acres will be under irrigation in the Puget Sound Area by the year 2020. The extent of potentially irrigable lands is shown on Figure 2-1.

### Land Characteristics

Soils of the Area have developed under the influence of humid climate and moderate temperatures. For the most part, they are slightly to moderately acid in the surface soil and become less acid with depth, and are free from accumulations of soluble salts. In the northern and central basins surface soil textures are generally medium to fine, of medium grade structure, and they are friable. Subsoils generally have medium grade, subgranular, blocky structure which ranges in consistence from friable to firm. The occurrence of water stable aggregates or granules in all or nearly all of the soils allows free movement of water into and through the soil while maintaining a desirable moisture holding capacity. Natural fertility is moderate to high but addition of fertilizers gives favorable economic returns.

Recent alluvial bottom and terrace lands are suited to the production of all crop adapted for the climate, which includes grass and legumes of pasture, strawberries, raspberries, potatoes, alfalfa, and vegetable crops. Local soil and drainage conditions may limit production to specialized crops in certain areas. The higher-lying, hilly, glacial lands are best suited to production of pasture crops. However, some of the adapted general farm crops could be grown on these lands.

Generally, the Area's potentially irrigable lands are well adapted to sprinkler irrigation. The gravelly outwash plains are generally smooth and slightly sloping. The glacial uplands are generally undulating to rolling, but the steepness of the predominant slope is well within the limits established in the land classification specifications.

About one-fourth of the potentially irrigable lands have varying degrees of drainage problems. On the glacial upland soils the deficiency is primarily internal, and sprinkler application would be the practicable method on these lands. Most of the potentially irrigable lands with drainage problems could be improved by using tile shallow surface drains, and improvement of natural channels for removal of heavy winter precipitation.

Estimates for the cost of clearing timber from potentially irrigable lands range from $200 to $500 per acre. And, the range of cost to remove stumps and brush after the timber is cut is $150 to $250 per acre. The usual clearing procedure consists of cutting the saleable timber first, collecting the stumps, brush, and trash timber into windrows or piles, and drying and burning. No continued clearing program is underway–most of the work is being done in the farmer's spare time. Nearly all of the timber land is in second growth stock, the majority of which is of commercial value.

### Land Classes

Potentially irrigable lands total 424,300 acres, of which 108,500 are presently in woodlands. The land classes of the potentially irrigable lands in the Puget Sound Area are shown in Table 2-10.

**TABLE 2-10. Economic classification of potentially irrigable lands in the Puget Sound Area.**

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 16,000 | 2,100 | 18,100 |
| 2 | 96,500 | 18,600 | 115,100 |
| 3 | 193,000 | 87,800 | 280,800 |
| Other[1] | 10,300 | ... | 10,300 |
| Total | 315,800 | 108,500 | 424,300 |

[1]These lands were not identified by class because they are expected to be supplanted by urban development in the near future.

## PROJECTION OF FUTURE IRRIGATION

From analysis of studies conducted by the Irrigation Committee and the Agriculture Committee, it was determined that if the Puget Sound Area is to maintain to the year 2020 the relative regional position in the production of food and fiber that it holds today, 525,000 acres of high quality cropland will have to be in production. This projection incorporates the assumption that the remaining available farmland will be farmed to productive levels currently reached by the top producers in the Puget Sound Area at the present time.

In order to satisfy the year 2020 production requirements, 396,000 acres of the farmland would need to be irrigated. However, the encroachment of the urban and suburban population and industrial s ector onto the better irrigable lands would limit to 223,000 the number of acres which actually would be capable of sustaining economical irrigation in the year 2020 regardless of the needs. Therefore, projections of future irrigated lands was based upon what is expected to occur. These projections incorporate estimated needs for food and fiber, availability of adequate water supplies, and location and extent of potentially irrigable lands. Projections are that about 131,000 acres of additional lands will be under irrigation in the Puget Sound Area by the year 2020. The total acreage expected to be irrigated in each basin by 1980, 2000 and 2020 is shown in Table 2-11.

**TABLE 2-11. Projected irrigation by basin.**

| Basin | Present (acres) | 1980 acres) | 2000 (acres) | 2020 (acres) |
|---|---|---|---|---|
| Nooksack-Sumas | 38,400 | 58,400 | 78,400 | 78,400 |
| Skagit-Samish | 6,200 | 16,200 | 26,200 | 51,200 |
| Stillaguamish | 2,500 | 6,500 | 10,500 | 10,500 |
| Whidbey-Camano Islands | 2,700 | 2,700 | 2,700 | 2,700 |
| Snohomish | 12,800 | 14,800 | 18,700 | 20,000 |
| Cedar-Green | 2,600 | 1,800 | 900 | 1,100 |
| Puyallup | 3,700 | 6,200 | 11,200 | 13,700 |
| Nisqually-Deschutes | 5,600 | 7,800 | 12,800 | 20,800 |
| West Sound | 1,200 | 1,600 | 2,100 | 2,600 |
| Elwha-Dungeness | 15,900 | 22,000 | 22,000 | 22,000 |
| San Juan Islands | 100 | 100 | 100 | 100 |
| Puget Sound Area | 91,700 | 138,100 | 185,600 | 223,100 |

The Agricultural Base Study projects that the present agricultural farmland will decline from its present level of 486,000 acres to 225,000 acres in the year 2020. The projections of future irrigated lands correspond closely with the agricultural base study projections.

The additional food and fiber needs which cannot be attained in the Puget Sound Area will have to be supplied from sources outside of the area.

### Irrigation Water Requirements

The determination of irrigation water requirements is based on consideration of several factors including temperature, effective precipitation, soil characteristics, cropping practices, crop consumptive use, farm efficiency in application of irrigation water, and distribution system losses and waste. Requirements for each basin in the Puget Sound Area were estimated using the Blaney-Criddle procedure, and recorded climatological data for a five-year period constituting a critically-dry period.

Unit irrigation requirements for each basin have been shown previously in Table 2-3.

# MEANS TO SATISFY NEEDS

Water supplies for future irrigation can be developed economically in parts of the Puget Sound Area by individual means. In some areas such as the Sequim area of the Elwha-Dungeness Basins project-type development is probably the best way of bringing new lands under irrigation. Readily available and easily developed water supplies in some of the basins are limited, and in these areas some type of project development will probably be necessary to bring all projected lands under irrigation in the future.

## PROJECTED IRRIGATION DIVERSIONS

Under the projected irrigation development, the irrigation diversions and depletions for each basin are shown in Table 2-12.

## COSTS OF IRRIGATION DEVELOPMENT

Costs associated with irrigation development vary widely depending on the source of water and on the type of system necessary to get the water to the land. Some areas have adequate ground water at shallow depth or an abundant supply of surface water at a reasonable distance from the land. In other areas it may be necessary to build long pipelines to transport the water to the land or to develop storage in order to provide an adequate water supply.

### Project-Type Development

In areas where adequate water supplies are not readily available to the farm, it may be necessary for the landowners to form an organization to develop a project through local assistance or with assistance from the Federal Government. With a project-type development, irrigation water would be supplied to the lands involved through a project transmission line and lateral distribution system. A buried pipe pressure system, which would supply water to the individual farm would cost about $600 to $1,000 per acre depending on the size of the project distance from source of supply, and elevation of the irrigated lands from the water supply source. The farmer would connect his mainline to a project turnout to receive water at a pressure adequate to operate his sprinkler system. If upstream storage is required to meet water supply needs, additional costs would be involved. Annual operation, maintenance, replacements and power costs for a project system would range from $5 to $10 per acre. Total costs for this type of a system (not including costs of storage) would be:

| Item | Cost per Acre |
|---|---|
| On-farm sprinkler system | $ 70 to $ 150 |
| Project distribution system | $600 to $1,000 |
| Initial cost | $670 to $1,150 |
| Annual operating costs on farm | $ 3 to $ 8 |
| Project operation costs | $ 5 to $ 10 |
| Total | $ 8 to $ 18 |

### Individual Farm Systems

In all developments each farm would require a farm distribution system after the water is brought to the land. A sprinkler system is the most modern method for distributing the water on the land. The cost of this system would depend on the size of the

**TABLE 2-12. Projected irrigation diversions and depletions (1000's of acre-feet)**

| | Present | | | | 1980 | | | | 2000 | | | | 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diversion | | Depletion | | Diversion | | Depletion | | Diversion | | Depletion | | Diversion | | Depletion | |
| | SW | GW | SW | GW | SW | GW | SW | GW | SW | GW | SW | GW | SW | GW | SW | GW |
| Nooksack-Sumas | 29.0 | 44.0 | 20.0 | 30.0 | 33.0 | 78.0 | 23.0 | 53.0 | 71.0 | 78.0 | 49.0 | 53.0 | 71.0 | 78.0 | 49.0 | 53.0 |
| Skagit-Samish | 3.6 | 8.4 | 3.5 | 8.0 | 7.6 | 23.5 | 7.2 | 22.9 | 17.6 | 32.7 | 16.5 | 32.2 | 56.6 | 42.7 | 53.7 | 41.5 |
| Stillaguamish | 3.5 | 1.3 | 2.4 | 0.9 | 7.5 | 5.0 | 5.1 | 3.6 | 11.5 | 8.7 | 7.8 | 6.3 | 11.5 | 8.7 | 7.8 | 6.3 |
| Whidbey-Camano Islands | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 | 1.9 | 5.5 |
| Snohomish | 11.9 | 12.6 | 8.9 | 8.3 | 20.9 | 7.3 | 10.4 | 9.1 | 26.4 | 9.3 | 14.2 | 10.4 | 28.9 | 9.3 | 15.9 | 10.4 |
| Cedar-Green | 4.5 | 1.1 | 3.0 | 0.8 | 3.1 | 0.8 | 2.1 | 0.5 | 1.5 | 0.4 | 1.0 | 0.3 | 2.0 | 0.4 | 1.3 | 0.3 |
| Puyallup | 6.0 | 3.8 | 3.4 | 2.3 | 9.0 | 5.7 | 5.7 | 3.9 | 17.0 | 9.5 | 10.8 | 6.5 | 21.0 | 11.5 | 13.4 | 7.7 |
| Nisqually-Deschutes | 8.1 | 5.2 | 5.3 | 3.4 | 8.6 | 9.9 | 5.6 | 6.5 | 11.0 | 12.4 | 7.1 | 12.7 | 15.0 | 34.3 | 19.5 | 22.5 |
| West Sound | 2.5 | 0.6 | 1.7 | 0.4 | 3.3 | 0.8 | 2.3 | 0.5 | 4.3 | 1.1 | 3.0 | 0.7 | 5.3 | 1.3 | 3.7 | 0.9 |
| Elwha-Dungeness | 75.0 | --- | 75.0 | --- | 104.0 | --- | 104.0 | --- | 104.0 | --- | 104.0 | --- | 104.0 | --- | 104.0 | --- |
| San Juan Islands | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Total | 146.0 | 82.5 | 125.1 | 59.6 | 198.9 | 136.5 | 167.3 | 106.5 | 266.2 | 164.6 | 215.3 | 127.6 | 316.2 | 191.7 | 260.4 | 148.1 |

farm, field layout, crops grown, water requirements and management practices. Mainline and lateral pipe, sprinkler heads, raisers and valves would normally cost about $70 to $150 per acre. Annual operation, maintenance and replacement costs would range from $3 to $8 per acre.

In areas where an adequate supply of ground water or surface water is available at the farm, an additional cost of about $25 per acre for a pump and related equipment would be necessary. Annual power and pump O&M costs would be about $4 to $8 per acre. Total costs to the farmer, at 1968 prices, for irrigation service under these conditions would be:

| Item | Cost per Acre |
|---|---|
| On-farm sprinkler system | $70 to $150 |
| Pump and motor | $25 to $ 25 |
| Total investment | $95 to $175 |
| Annual operation, maintenance and replacements | $ 3 to $ 8 |
| Power and Pump O&M | $ 4 to $ 8 |
| Total | $ 7 to $ 16 |

Average costs of irrigation systems have been prepared for all basins where irrigation development is expected to occur. The costs are for both a project type system and individual farm systems. The system costs include both federal and private investment and are shown in Table 2-13.

## BENEFITS FROM IRRIGATION DEVELOPMENT

Irrigation benefits have been estimated for single-purpose project-type irrigation systems expected to be constructed prior to 1980. These include both primary and secondary benefits.

Lands in farms, as presented in Exhibit A of the Economic Base Study is projected to be reduced to 78 percent of the present amount by 1980. However, land losses from agricultural uses are not identified as to basin or location within a basin. In order to derive benefits from irrigation development, the lands that are to be irrigated must be specifically identified. This is necessary because the costs of developing and serving land with water must be derived in order to make farm budget analyses. Therefore the detailed engineering and agricultural economy studies needed for making a benefit analysis cannot be accomplished for nonproject development since it is not known where within each basin irrigation development will occur.

However, the additional gross income which would accrue to the farmer for irrigating has been determined. This gives an indication of its relative value. To obtain a net value, the farm operating costs attributable to irrigation must be deducted. Net irrigation values were not determined as the derivation of these values are beyond the scope of this study.

**TABLE 2-13. Projected irrigation investment ($1000)**

| Basin | Present-1980 Private | Present-1980 Federal | 1980-2000 Private | 1980-2000 Federal | 2000-2020 Private | 2000-2020 Federal |
|---|---|---|---|---|---|---|
| Nooksack-Sumas | 2,700 | -- | 2,200 | 20,000 | -- | -- |
| Skagit-Samish | 1,350 | -- | 1,100 | 6,000 | 2,750 | 15,000 |
| Stillaguamish | 540 | -- | 540 | -- | -- | -- |
| Whidbey-Camano Is. | -- | -- | -- | -- | -- | -- |
| Snohomish | 820 | -- | 530 | -- | 180 | -- |
| Cedar-Green | | -- | 55 | -- | 55 | -- |
| Puyallup | 340 | -- | 680 | -- | 340 | -- |
| Nisqually-Deschutes | 300 | -- | 680 | -- | 1,080 | -- |
| West Sound | 50 | -- | 70 | -- | 70 | -- |
| Elwha-Dungeness | 770[1] | 14,610 | -- | -- | -- | -- |
| San Juan Is. | -- | -- | -- | -- | -- | -- |
| TOTAL | $6,870 | $14,610 | $5,850 | $26,000 | $4,480 | $15,000 |

[1] 900 Ac. presently gravity irrigated and 6,100 Ac. new lands.

**TABLE 2-14. Additional gross income per acre associated with irrigation use**

| Basins | Total Additional Gross Income | Acres Normally Irrigated | Additional Gross Income Per Acre |
|---|---|---|---|
| Nooksack-Sumas | $1,630,000 | 17,000 | $96 |
| Skagit-Samish | 418,000 | 6,200 | 67 |
| Stillaguamish | 158,000 | 2,200 | 72 |
| Whidbey-Camano Islands | 46,000 | 900 | 51 |
| Snohomish | 893,000 | 12,800 | 70 |
| Cedar-Green | 579,000 | 2,600 | 223 |
| Puyallup | 493,000 | 3,700 | 133 |
| Nisqually-Deschutes | 450,000 | 5,600 | 80 |
| West Sound | 187,000 | 1,200 | 156 |
| Elwha-Dungeness | 1,429,000 | 15,900 | 90 |
| San Juan Islands | 3,000 | 100 | 30 |

As developed in the Irrigation Economy section of this Appendix the additional annual gross income which would accrue to the farmer for irrigating varies from $30 to $223 per acre. These amounts are based on present day values, cropping patterns, and levels of production and do not reflect future improved technology and management practices which will likely result in increased yields per acre from irrigating. Neither does it reflect changes in the irrigated cropping pattern, i.e., shifts from low value per ton forage crops to high value per ton vegetable and berry crops, which are likely to occur in the future. Table 2-14 summarizes the additional gross income per acre by Basin associated with irrigation use.

## IMPACT ON THE ECONOMY FROM IRRIGATION

Agriculture is an important industry in the Puget Sound Area and irrigation has increased its value to the economy.

A recent study has shown that irrigation favorably influences the economic growth of local communities.[1] It indicated that in addition to the increased value of agricultural output, other measures of economic growth were also achieved by various sectors of the local economy responding to the additional volume of agricultural production resulting from irrigation.

[1] Economic Development of the Columbia Basin Project Compared with a Neighboring Dryland Area, EM 2601, January 1966 Cooperative Extension Service, Washington State University.

In the study cited above, every $1,000,000 of sales of farm products from irrigated land resulted in $810,000 in gross revenue to local processing and marketing firms and $1,620,000 in gross receipts to local retail, wholesale and service trades.

In addition to stimulating local business and industry income, irrigation creates a demand for more farm labor and labor to process the additional farm products and work in business and trades serving farmers and processors. The study showed that every $1,000,000 of sales of farm products from irrigated land resulted in 70.6 man-years of farm employment. Employment in agricultural processing was 25.2 man-years per $1,000,000 of processing revenue from irrigated crops and associated livestock products, and 62.2 man-years of work resulted from every $1,000,000 of gross receipts of retail, wholesale and service trades that supported irrigated farming and processors of irrigated agricultural products.

Table 2-15 shows the result of applying these factors to the increased value of agricultural production resulting from irrigation as shown in Table 2-4.

**TABLE 2-15. Economic impact of irrigation on income and employment in the Puget Sound Area**

| Industry | Gross Income ($1000) | Related Employment (Man-Years) |
|---|---|---|
| Basic Agriculture | 6,286 | 440 |
| Processing | 5,092 | 130 |
| Trades and Services | 10,182 | 630 |
| | 21,561 | 1,200 |

## FEDERAL AND STATE ASSISTANCE

The principal Federal and State agencies responsible for constructing and/or supplying local assistance for developing an irrigation system are the Bureau of Reclamation, Soil Conservation Service, and the Washington State Department of Water Resources. Each of these agency's authorities and responsibilities for developing or assisting in the development of an irrigation system differs. The agency authorities and responsibilities are outlined in the following paragraphs.

### Bureau of Reclamation

The Bureau of Reclamation is the agency within the United States Department of the Interior having responsibility for development of irrigation projects in the western states. Although irrigation development has long been a part of the Bureau's program functions such as power, recreation, fish and wildlife, municipal and industrial water supplies, flood control, navigation, water quality control, area redevelopment and sedimentation are considered in formulating development plans.

Broadly, the Bureau's responsibilities are to: (1) investigate and develop jointly with other related State and Federal agencies plans for potential projects to conserve and utilize water and related land resources, (2) design and construct authorized projects for which funds have been appropriated by the Congress; (3) operate and maintain projects and project facilities constructed by the Bureau, and inspect the operation and maintenance of projects and project facilities constructed by the Bureau but operated and maintained by water users; and, (4) negotiate, execute and administer repayment contracts, water service contracts, and water-user operation and maintenance contracts.

In addition the Bureau of Reclamation administers the program authorized under the Small Reclamation Projects Act of 1956. This Act, as amended June 5, 1957 and September 2, 1966, established a program under which certain types of organizations can obtain loans for small reclamation projects and grants for those portions of the projects that are nonreimbursable as a matter of national policy.

Initial interest for developing a reclamation project must come from the local landowners. A detailed study is necessary to determine how the land and water resource could best be utilized. The project plan is developed with local participation and assistance. Congress must approve the project and appropriate funds before construction can start.

The concept of reimbursability is a major controlling factor in all reclamation financial and formulation activities. Federal Reclamation Law requires that all costs allocated to irrigation be repaid to the Federal Government over a 40-year period without interest. Annual operation and maintenance costs also must be fully borne by the water users. The law further provides for an initial development period of up to ten years during which no repayment of construction costs are required. When appropriate, specific projects are authorized by Congress to allow for a 50-year repayment period. Irrigators repay construction costs within their ability to pay. Costs beyond the irrigator's ability to repay may be returned to the Federal Treasury through surplus Federal power revenues or from other sources of revenue as derived by the Secretary.

The amount the landowners would be expected to pay for an irrigation project is determined from economic studies. Factors considered in these studies include types of soil, crops that can be grown, transportation costs, market, type of irrigation service provided, and farm costs.

For a more detailed explanation of the Bureau of Reclamation's programs and responsibilities see Appendix II, Political and Legislative Environment.

### Soil Conservation Service

The Soil Conservation Service is the agency of the United States Department of Agriculture given the responsibility of developing and carrying out a national soil and water program through local soil and water conservation districts organized under State law. In this work the Service brings together scientists and technologists from many fields to assist individual landowners with the conservation development and multiple uses of land and water resources.

The Soil Conservation Service emphasizes technical assistance provided through individual conservation plans and agreements detailing proper land use. Included in this assistance are soil classifications and interpretations, and detailed plans for the development, storage, conveyance and application of irrigation where applicable. Landowners needing assistance of this nature apply for such services through their local soil and water conservation districts.

The Watershed Protection and Flood Prevention Act (Public Law 566) is intended to enable local people to cope with flood siltation and erosion

damage in watershed areas up to 250,000 acres in size. The act further provides for water storage needs for agricultural water management, public recreation and fish and wildlife development in addition to soil and water conservation and flood prevention. Emphasis is on multiple use of such projects.

The projects are initiated by local people who assist in planning, construction, operation, maintenance and financing. Local people own all the structures that may be built. On approved projects the Federal Government pays for all engineering services and up to 50 percent of the construction cost for irrigation and drainage facilities.

Local interests pay other costs including cost of land rights, and costs of including municipal and industrial storage in structures.

Projects may be sponsored or co-sponsored by any agency qualified under State law. These include various departments of the State Government, soil and water conservation districts, improvement districts, municipalities, counties and other special purpose districts. Application forms can be obtained from the Washington State Department of Water Resources or from the Soil Conservation Service.

Additional information on the Soil Conservation Service's programs and responsibilities is contained in Appendix II, Political and Legislative environment.

### State of Washington

The State Department of Water Resources has the responsibility for participating and assisting in the planning, development and utilization, of the water and related land resources for the Puget Sound Area.

In accordance with the authorities, powers and duties set forth in the respective State statutes, the Department of Water Resources will:

1. Assist in the determination of the need for and in the organization of irrigation districts or other organization for this purpose.
2. Encourage, advise and assist individuals and groups of landowners and operators in the planning and development of irrigation systems and projects.
3. Make studies or investigations of the sufficiency of the source and supply of water, nature of the soil and its susceptibility to irrigation, the duty of water for irrigation, the probable need for drainage, probable cost of facilities, water rights and other property rights necessary for the project and such other matters as deemed pertinent to the success of the project.
4. Process applications for the appropriation of public surface and groundwaters, issue permits and water right certificates. Provide field supervision in the enforcement and regulation of diversions and withdrawals in accordance with established rights.
5. Within the limits prescribed by State statutes, the Department may make loans to irrigation and reclamation districts from the "Reclamation Revolving Fund" for specified periods of time, specified rates of interest, and schedules of repayment. These funds may be used for construction of new projects, rehabilitation and/or extension of present projects.

Additional information on the State Department of Water Resources' programs and responsibilities is contained in Appendix II, Political and Legislative Environment.

## FUTURE IRRIGATION CONSIDERATIONS

New concepts in the field of irrigation will likely be adopted as development of water and land resources in the Puget Sound Area progresses. Two such concepts that would have an impact on future needs for irrigation in the Area, if practically applied, are: (1) utilization of cooling water from thermal generating plants as a source of irrigation water supply; and, (2) irrigation of forest lands.

### Thermal Generation and Irrigation

As the demand for electric power increases in the Puget Sound Area, additional sources of generation will be required. Thermal generation is one alternative for future supply. A consideration in planning for development of thermal generating plants is determining satisfactory methods for disposing of waste heat. If a generating plant could discharge its cooling water directly into an irrigation system in lieu of costly cooling devices, benefits could accrue to the plant, the irrigation project and downstream water users. There will be need for considerable coordination in planning to match irrigation projects and generating plants in location and size. Interest in such studies is developing and if feasible plans can be formulated there would be a significant impact on irrigation possibilities in the Puget Sound Area.

### Forest Land Irrigation

Irrigation has long been used in agriculture for increasing the yield of field crops, however, the technique has had virtually no application to forest

lands. For various reasons, irrigation practices have not been applied extensively to forest lands in the past; however, the ever increasing demand for wood fiber, combined with a continuing decrease in the area devoted to forest production, makes it imperative that yields from the remaining lands be increased. Irrigation is one of the most promising means of accomplishing this purpose. The next century will almost certainly see a wider application of irrigation to forest lands in those areas where it is both physically and economically feasible, and where water is available for such use. As a result, a determination of the potential for forest land irrigation is of considerable importance in long-range water resource planning.

Since irrigation has not been applied to forest lands except on an experimental basis, there is a limited amount of data based on field trials. An estimate of potentially irrigable land can be made by an analysis of the character and composition of forest soils. The soil is a major factor affecting the yield from forest lands and is also the most important consideration in determining the suitability of the land for irrigation. Detailed soils information, provided by the Soil Conservation Service is available for the Puget Sound Area. The estimate of potentially irrigable forest land is based on an analysis of this soil data.

The results of this analysis are not precise, but are considered a reasonably accurate estimate of the potential for forest land irrigation. The soils also serve to indicate the magnitude of water use that might occur should this practice be undertaken. The results are shown in the following tabulations:

The estimate is based largely on physical land characteristics and is not an analysis of the feasibility of forest land irrigation. Such a feasibility analysis would have to consider the management intent of the landowners, the expected increase in yield of wood products due to irrigation, the long-term cost of water and its application to the land, and the availability of water for this purpose. This type of analysis is complex and beyond the scope of this study.

To provide a measure of the yield which could be expected from irrigation, a Douglas fir site index rating based on measurements of trees growing in the Puget Sound soils was used. If, through application of irrigation, the site index of the water deficient soils could be raised from the present median of 136 to 157, an increase in yield of 15 percent could be realized from these lands. Of course, there are limiting factors other than water that affect land productivity, however, these apply to a greater extent on those soils which were not classified as water deficient. It is therefore considered that a 15 percent increase is conservative.

On the basis of saw logs for a 100-year rotation, the anticipated increase in yield would be about 26,000 board feet per acre, International ¼ rule.[1]

At the present time little is known of the actual productivity or value of using thermal cooling water for irrigation or the irrigation of forests. The Irrigation Committee does recognize the potential of this resource and recommends that should these applications become feasible in the future, they should be incorporated into the plan for the Puget Sound Area.

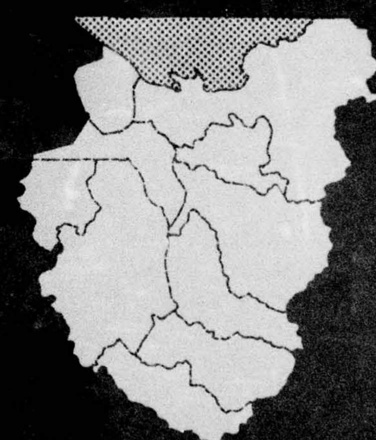
[1] Conversion from Index to Board Feet taken from Yield of Douglas Fir in the Pacific Northwest, Technical Bulletin No. 201, U.S.D.A.

| Basin[1] | Primary Area[2] (acres) | Secondary Area[3] (acres) | Total Area (acres) | Total Water Requirements (acre-feet) |
|---|---|---|---|---|
| Nooksack-Sumas | 45,200 | 9,300 | 54,500 | 180,000 |
| Skagit-Samish | 17,700 | 7,200 | 24,900 | 82,000 |
| Stillaguamish | 14,600 | 6,000 | 20,600 | 68,000 |
| Snohomish | 41,100 | 62,000 | 103,200 | 340,000 |
| Cedar-Green | 10,000 | 37,800 | 47,800 | 158,000 |
| Puyallup | 48,500 | 33,400 | 81,900 | 270,000 |
| Nisqually-Deschutes | 80,100 | 46,500 | 126,600 | 418,000 |
| West Sound | 91,700 | 79,700 | 171,400 | 566,000 |
| Elwha-Dungeness | 4,100 | -- | 4,100 | 13,000 |
| TOTAL | 353,000 | 281,900 | 635,000 | 2,095,000 |

[1] Whidbey, Camano and San Juan Islands lands were omitted as they are not considered suitable for commercial forest culture on a significant scale.

[2] 0 to 8 percent slope. [3] 8 to 15 percent slope.

# Nooksack-Sumas Basins



# NOOKSACK—SUMAS BASINS

The Nooksack-Sumas Basins are in northern Washington, almost entirely within Whatcom County. Extending south from British Columbia to the Skagit Basin and east from the Strait of Georgia to the Cascade Range, the area includes the drainage systems of the Nooksack River, portions of the Sumas and Chilliwack River drainages, and several minor drainage basins tributary to the Strait of Georgia.

The eastern portion of the Basins, extending into the Cascade Range, is characterized by rugged, heavily forested, mountainous terrain. Much of the eastern part is presently managed for wilderness recreation areas by the U.S. Forest Service.

West of Deming are hummocky glacial plateaus connected by gentle slopes grading down to broad river valleys. The upland plateaus tend to consist of rolling hills composed of soils with slowly to very slowly permeable substrata. The Nooksack and Sumas floodplains make up much of the lowlands.

The Nooksack River drains 777 square-miles within the Nooksack-Sumas drainage from its source on the western slopes of Mt. Baker to Bellingham Bay. The Middle and South Forks join the main stream above the town of Deming. Below Deming, the river flows through a broad alluvial plain for 37 miles, discharging into Bellingham Bay. The Sumas River, which originates on Sumas Mountain near North Cedarville, meanders through a broad, fertile valley and crosses the border into Canada at the city of Sumas, draining about 56 square miles in the United States. The largest tributary, Johnson Creek, joins the Sumas River just east of the city of Sumas, draining much of the western part of the Sumas Valley. The Chilliwack River drains about 174 square miles at the extreme eastern part of the basin before crossing into Canada.

The climate is characterized by cool summers and moist, mild winters. Average annual precipitation

**PHOTO 3-1. General view of Nooksack Valley, looking southeast toward Mount Baker with Lynden in foreground.**

ranges from 32 inches near the Puget Sound to over 100 inches on Mt. Baker. About 75 percent of the precipitation occurs during the winter months (October-March). Average monthly temperatures at Bellingham range from 36°F in January to 61°F in August.

Croplands are located mainly on the rich alluvial low lands. Woodland use predominates as the elevation increases. Much of the higher mountainous area of forest and alpine land is in Federal ownership. Land use within the Basins is shown below:

| | Acres |
|---|---|
| Cropland | 137,000 |
| Rangeland | 12,000 |
| Forest | 609,000 |
| Rural nonagricultural | 13,000 |
| Built-up areas | 21,000 |
| Total | 792,000 |

**PHOTO 3-2. Typical dairy farm near Lynden. (USBR photo)**

Whatcom County, (essentially the Nooksack-Sumas Basins), is the leading dairy county of the State of Washington and ranks eighth within the State in the value of all farm products sold. Timber production is a major industry with woodland comprising about 75 percent of the area of the Basins.

Deep water ports at Bellingham and Blaine are major contributors to the Basins' development. Major industries in this area include petroleum refining and storage, pulp and paper mill operations, and an aluminum plant. New and expanding industrial activity emphasizes the growing importance of deep-draft access adjacent to available large land areas. In 1967, a site at Bellingham was being developed for industrial use through the reclamation of tidelands.

The population of Whatcom County has shown an irregular but steady growth, and is now about half urban and half rural. Whatcom County has grown from 60,335 in 1940 to 70,317 in 1960, an increase of 15.8 percent, which is considerably less than the national rate of increase of 36.2 percent for the same period.

Bellingham, with a population of 36,500, is the largest city in the Basins and is the principal trading center.

# PRESENT STATUS

Development of irrigation in the Nooksack-Sumas Basins following World War II has been both rapid and extensive. However, unlike the arid regions of the State, the acreage irrigated varies from year to year, depending upon the amount of precipitation received during the growing season. For example, the U.S. Census of Agriculture reported about 16,700 acres irrigated in 1959, a year with near average precipitation during the growing season. By contrast, in 1964, a year with above normal precipitation, only 4,500 acres were irrigated. The close relationship of growing season precipitation with irrigation use is further illustrated in the dry 1965 season when 38,400 acres were irrigated. Based upon crop irrigation requirements and average growing season precipitation, the annual acreage normally irrigated is about 17,000 acres. Figure 3-1 illustrates the relationship between crop consumptive use, effective precipitation and crop irrigation requirement.

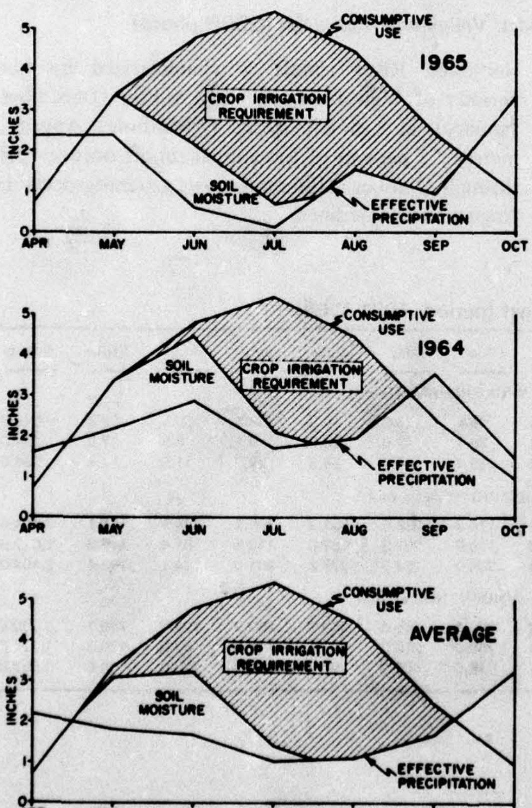



**FIGURE 3-1. Crop irrigation requirements for typical dry, wet and average years.**

## IRRIGATED LANDS

Nearly all of the presently irrigated lands are located in the lowlands along the Nooksack and Sumas rivers and on the benchlands north of Lynden. The remaining irrigated lands occur irregularly throughout the Basins.

Soils of the irrigated lands vary considerably in characteristics and quality. Surface soils range in texture from silty clay loam to sandy loam, and subsoils from dense clays to sand and gravel.

Topography of most of the irrigated lands is nearly level to slightly undulating. Most of the lands are sprinkler irrigated.

Irrigated lands were classified as class 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 3-2. A summary of the lands irrigated in 1965, is shown below.

| Land Class | Irrigated (Acres) |
|---|---|
| 1 | 6,410 |
| 2 | 25,320 |
| 3 | 6,670 |
| Total | 38,400 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Irrigation has generally developed near the Nooksack River, small tributaries, and where ground water is easily obtained. The water supply for irrigated lands is obtained from wells and individual diversions from the Nooksack River, Sumas River, coastal streams, and their tributaries. Some small lakes in the area also serve as a source for irrigation water. About 60 percent of the presently irrigated

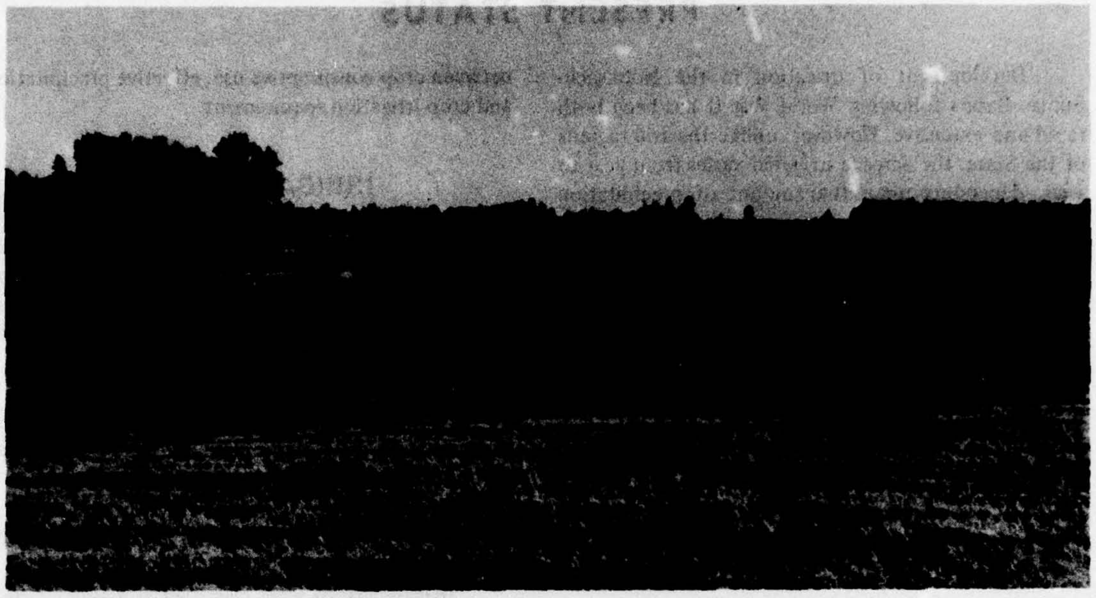


PHOTO 3-3. Typical view of farmlands in the Nooksack Valley near Ferndale. (USBR photo)

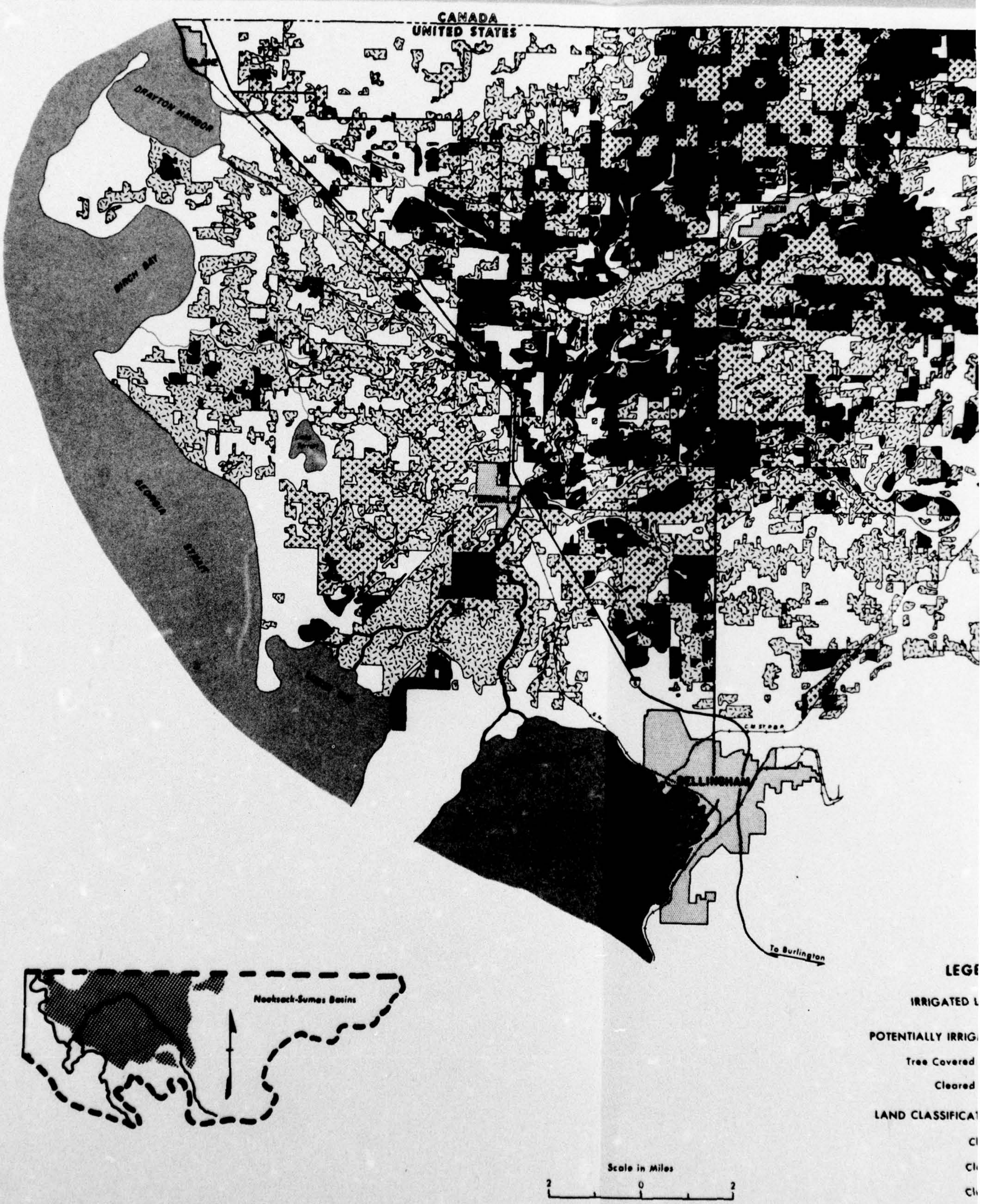
lands receive their water supply from ground water and 40 percent from surface sources.

The Nooksack-Sumas Basins have a relatively large surface water resource. The annual runoff of the Nooksack River near Lynden, averages 2.5 million acre-feet. Monthly and annual runoff at selected sites on the Nooksack River are shown in Table 3-1.

Nooksack River runoff is characterized by two periods of high flow; in early winter (December-January), and in late spring (April-June). Approximately 55 percent of the annual runoff occurs April through October. Minimum flows generally occur in August and September.

**TABLE 3-1. Monthly and annual runoff—1000's of acre-feet (period: 1931-1960)**

| | Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOUTH FORK NOOKSACK near WICKERSHAM: (103 sq. mi.) | | | | | | | | | | | | | | |
| Max. | (1954) | 55.5 | 69.8 | 88.0 | 52.0 | 67.2 | 35.6 | 48.4 | 73.0 | 76.2 | 56.5 | 30.8 | 22.3 | 675.0 |
| Min. | (1944) | 23.1 | 18.5 | 48.8 | 49.4 | 28.2 | 32.4 | 36.1 | 49.9 | 28.8 | 9.1 | 6.8 | 22.9 | 354.0 |
| Mean | | 41.5 | 55.3 | 64.9 | 56.4 | 42.3 | 42.9 | 52.4 | 66.9 | 54.9 | 27.7 | 11.9 | 17.4 | 534.0 |
| NOOKSACK RIVER at DEMING: (584 sq. mi.) | | | | | | | | | | | | | | |
| Max. | (1954) | 241.2 | 334.2 | 402.8 | 249.3 | 290.4 | 161.2 | 174.3 | 288.6 | 331.3 | 325.2 | 204.1 | 141.1 | 3,144.0 |
| Min. | (1944) | 105.9 | 81.5 | 198.8 | 170.4 | 97.8 | 122.3 | 135.9 | 207.3 | 187.0 | 110.5 | 81.4 | 118.0 | 1,617.0 |
| Mean | | 175.1 | 218.7 | 255.9 | 217.2 | 167.0 | 177.8 | 206.0 | 284.9 | 279.8 | 201.0 | 114.1 | 106.4 | 2,404.0 |
| NOOKSACK RIVER near LYNDEN: (648 sq. mi.) | | | | | | | | | | | | | | |
| Max. | (1959) | 226.1 | 323.8 | 382.5 | 372.5 | 144.9 | 194.8 | 351.1 | 346.4 | 343.8 | 252.7 | 129.9 | 240.1 | 3,309.0 |
| Min. | (1944) | 113.0 | 84.5 | 215.5 | 187.3 | 106.6 | 129.7 | 150.0 | 212.0 | 203.6 | 118.5 | 83.0 | 120.8 | 1,274.0 |
| Mean | | 181.4 | 232.8 | 277.4 | 238.0 | 183.6 | 192.1 | 216.0 | 301.7 | 293.2 | 209.9 | 116.0 | 108.6 | 2,551.0 |


CANADA
UNITED STATES
DRAYTON HARBOR
BIRCH BAY
GEORGIA STRAIT
BELLINGHAM
To Burlington
Nooksack-Sumas Basins
Scale in Miles
2 0 2
Tree Covered
Cleared

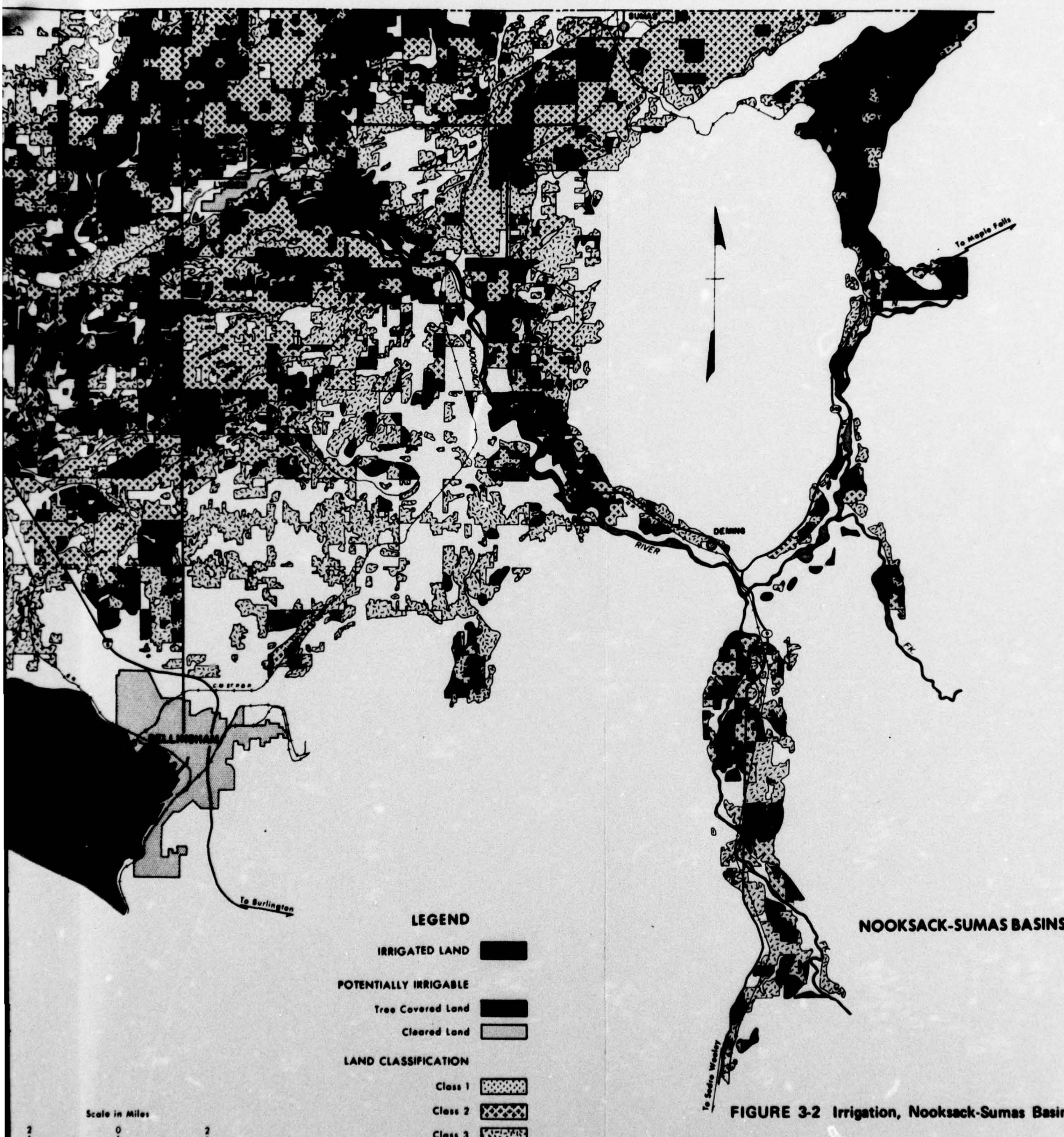



FIGURE 3-2 Irrigation, Nooksack-Sumas Basins



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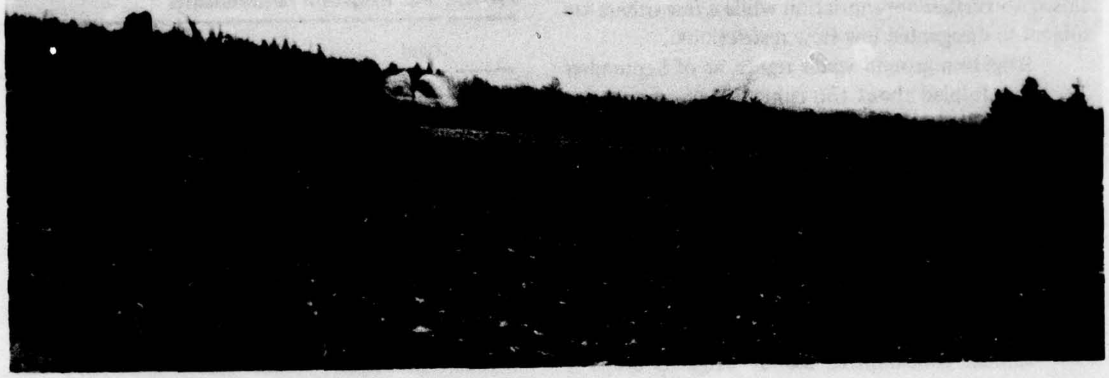


**PHOTO 3-4. Early cultivation of lands helps offset costs of clearing. Note large irrigation sprinkler in the background. (USBR photo)**

The flows of the small coastal streams and the Sumas River are typical of runoff patterns for streams in low altitude basins. Buildup of streamflow begins in December, reaches a maximum in February and decreases by March. Minimum flows occur usually in August and September.

Surface water is of excellent quality for irrigation use based on analysis of samples taken. Surface water has been used for irrigation for approximately 40 years with no apparent harmful effects on soils or crops. Most sediment problems are associated with erosion of steep mountain watersheds and bank erosion of sandy terrace deposits in the lowlands. This erosion is associated with high river flows, and presents no serious problems during the irrigation season.

An adequate supply of ground water exists in most lowland areas. The aquifers are river and glacial-deposited materials which extend throughout most of the western lowlands. Hydrographs of several observation wells show that natural recharge equals or exceeds annual withdrawal. High ground water yields can generally be obtained in the lowland sections of the Basins. Shallow wells in these areas produce yields of 100-200 gallons per minute with only 2-3 feet of drawdown.

Areas of low yield are generally in the upland areas, which are underlain with glacial till.

The ground water is of good quality although it contains more dissolved solids than the surface waters. Iron is the most objectionable constituent of the ground water supply. Generally, irrigation from wells has been practiced for over 20 years with no apparent harmful effects to soils or crops.

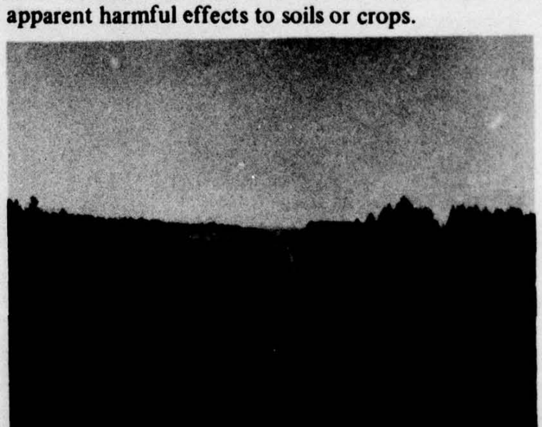


**PHOTO 3-5. Alfalfa under irrigation near Lake Wiser. (USBR photo)**

### Water Rights

There has been no adjudication of water rights in the Nooksack-Sumas Basins. As of April 30, 1967, there were about 13,000 acres of land which held a permit or certificate for a surface water right. The total diversion to serve this acreage, along with combined rights for stock and domestic water, is approximately 120 cubic feet per second.

Increased water use in recent years has created a conflict of interest on some minor tributaries. Several smaller streams and tributaries have been closed to further appropriation while a few others are subject to designated low-flow restrictions.

Irrigation ground water rights, as of September 30, 1966, totaled about 180 cubic feet per second for about 15,000 acres.

### Water Requirements

The irrigation requirements for the Nooksack-Sumas Basins have been estimated using climatological data from the Blaine station. The average precipitation at Blaine during the months of June, July and August is about 4 inches.

Annual consumptive use of irrigated crops is estimated at 1.85 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.71 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.14 acre-feet per acre. With an estimated farm irrigation efficiency of 63 percent, a farm delivery requirement of 1.81 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of 5 percent of the diverted amount, the normally irrigated lands (17,000 acres) require an average annual diversion of 32,000 acre-feet. About 60 percent of this is obtained from ground water and 40 percent from surface sources.

PHOTO 3-6. Irrigating grass south of Lynden. (USBR photo)

Monthly irrigation requirements during the growing season are shown in Table 3-2.

The 17,000 acres normally irrigated contribute an estimated annual net return flow of 10,000 acre-feet. The resulting depletion averages 22,000 acre-feet annually.

TABLE 3-2. Irrigation requirements

| Item | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|
| Distribution | 22% | 37% | 28% | 13% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .25 | .42 | .32 | .15 | 1.14 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .40 | .67 | .51 | .23 | 1.81 |
| Diversion Requirement (Acre-Feet/Acre) | .42 | .71 | .53 | .25 | 1.91 |

### Adequacy of Supply

With few exceptions the quantity of the waters in the Basins is adequate to meet the present irrigation needs of the area. Some small areas in the uplands near the edge of the Basins are deficient in ground water. Also, sufficient surface water is not available during periods of low flow on certain small tributaries. Many irrigators in the area tend to rely upon rainfall to meet their needs. In these cases, irrigation is used to prevent crop failure rather than to obtain optimum crop yields.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $869,000 from increased crop production, and $761,000 from increased production of livestock and livestock products, for a total value of $1,630,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

## Basic Data

Agricultural Census data for 1964 and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

## Number, Type, and Size of Farms

There are about 2,760 farms in the Nooksack-Sumas Basins. About 170, or six percent of the farms had irrigated cropland in 1964. As shown in Table 3-3, dairy and other livestock farms are the most common farming enterprises in the Basins identified by source of farm income.

**TABLE 3-3. Farm types–1964[1]**

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crop | 30 | 1.1 |
| Vegetable | 25 | 1.0 |
| Fruit and Nut | 120 | 4.3 |
| Poultry | 105 | 3.8 |
| Dairy | 975 | 35.3 |
| Other Livestock | 200 | 7.2 |
| General | 55 | 2.0 |
| Miscellaneous | 1,250 | 45.3 |
| Total | 2,760 | 100.0 |

1 Estimated from Census of Agriculture.

2 Rounded to the nearest 5.

The average size of commercial farms is about 80 acres and farms with irrigated cropland also average about 80 acres. Commercial farms with milk cows average about 32 cows per farm.

More than 70 percent of the irrigated cropland is in forage crops. Field crops and berries account for another 20 percent and the remainder is mostly in vegetables. Dairy farms and other livestock farms comprise the bulk of the farms with irrigated cropland.

## Crops

Total crop production related to irrigation use is shown in Table 3-4.

Most of the acreage devoted to forage is in grass-clover crops used for hay and pasture, although some is in corn silage. The early crop of grass, generally cut in May, is harvested for silage or green feed, as the weather is too wet to graze or make hay. Later in the season, this cropland is irrigated and grazed or harvested as hay. Some forage is cut for green feed all season. Most of the forage crops are used within the Basins.

**TABLE 3-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre[1] | Increased Production Related to Irrigation: Total[2] |
|---|---|---|---|---|
| Small Grains | 340 | Ton | .35 | 120 |
| Field Crops | 1,770 | Ton | 4.57 | 8,090 |
| Forages | 12,300 | | | |
| Hay | (6,640) | Ton | 1.33 | 8,830 |
| Pasture | (5,430) | AUM | 3.17 | 17,210 |
| Corn Silage | (230) | Ton | 2.00 | 460 |
| Vegetables | 930 | Ton | 2.70 | 2,510 |
| Snap Beans | (210) | Ton | (.85) | (180) |
| Beets | (60) | Ton | (5.00) | (300) |
| Carrots | (120) | Ton | (6.45) | (770) |
| Sweet Corn | (360) | Ton | (2.38) | (860) |
| Cucumbers | (180) | Ton | (2.20) | (400) |
| Berries | 1,660 | Ton | 1.18 | 1,960 |
| Strawberries | (930) | Ton | (1.13) | (1,050) |
| Raspberries | (680) | Ton | (1.26) | (860) |
| Blueberries | (50) | Ton | (1.00) | (50) |
| Total | 17,000 | | | |

1 See The Puget Sound Area for method of derivation.

2 Rounded to the nearest 10.

Potatoes are the major field crop grown. Growers expect to irrigate most of their acreage in a year with average precipitation. The Basins are a prime producer of seed potatoes in the State. The bulk of the production goes to California and Eastern Washington potato growers.

Sweet corn, snap beans, carrots, cucumbers, beets and green peas are the commercially important vegetable crops. All are irrigated to some extent. The acreage of irrigated green peas is negligible.

Almost all of the commercial vegetables produced in the Basins are marketed to processors. Most

are processed locally, although some are shipped to nearby cities outside the Basins.

Irrigated berries are the most important crops, in terms of gross value, grown in the Basins. Strawberries and raspberries are the major berry crops, although some blueberries are raised.

Most strawberries and raspberries are marketed to local and Canadian processors for freezing. Blueberries are sold mostly on the fresh market with Los Angeles receiving the major share of production.

Irrigated small grains, mostly oats, are frequently grown as a nurse crop when establishing new grass plantings. Because this is a feed grain deficient area, most of the grains raised locally are fed to livestock in the Basins.

## Crop Values

Crop values related to irrigation are shown in Table 3-5.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basins. Meat packing and dairy processing plants are located in Bellingham and Lynden. Dairy products are also processed at Mt. Vernon, 30 miles from Bellingham. The derivation of estimated animal units of feed requirements and production is shown in Table 3-6.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 4.5 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation, based on total digestible nutrient (T.D.N.) requirements, is shown in Table 3-7. The production is based on 4.5 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 3-6.

In terms of T.D.N.'s only, the full feed requirements of about 5,230 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all of their feed, and the nutritional requirements of many more than 5,230 head of cattle are partially satisfied by irrigated feeds.

## Livestock and Livestock Product Values

Estimated livestock values related to irrigation are shown in Table 3-8. The value estimates are based on the proportion of feed attributable to irrigation.

**TABLE 3-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value: Per Unit* (Dollars) | Value: Total (Dollars) |
|---|---|---|---|---|
| Field Crops | Ton | 8,090 | 22 | 178,000 |
| Vegetables | Ton | 2,510 | 41 | 102,900 |
| Berries | Ton | 1,960 | 300 | 588,000 |
| Small Grains | Ton | 120 | | ** |
| Forages | | | | |
| Silage-Corn | Ton | 460 | | ** |
| Hay | Ton | 8,830 | | ** |
| Pasture | AUM | 17,210 | | ** |
| Total | | | | 868,900 |
| Rounded | | | | 869,000 |

*Average prices received—adjusted normalized basis.

| | | | | |
|---|---|---|---|---|
| Snap Beans | - $130/Ton | | | |
| Beets | - $ 26/Ton | | | |
| Carrots | - $ 31/Ton | Strawberries | - | $270/Ton |
| Sweet Corn | - $ 26/Ton | Raspberries | - | $330/Ton |
| Cucumber | - $ 63/Ton | Blueberries | - | $390/Ton |

**Accounted for in livestock and livestock product values.

**TABLE 3-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 34,840 | 58,183 |
| Per Feeder | .58 | 2,170 | 1,259 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 8,180 | 10,389 |
| Per Feeder | .38 | 4,820 | 1,832 |
| Total | | | 71,663 |
| Rounded | | | 71,700 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grain | | | |
| Hay—Ton | 8,830 | .20 | 1,766 |
| Pasture—AUM | 17,210 | .08 | 1,377 |
| Small Grains—Ton | 120 | .29 | 35 |
| Corn Silage—Ton | 460 | .07 | 32 |
| Total | | | 3,210 |
| Rounded | | | 3,200 |

1 Rounded to the nearest 10 head.

2 Includes feed required for bulls and replacement stock usually associated with the breeding herd.

3 Animal Units of feed per ton/AUM.

**TABLE 3-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 35,742 head | 80,501 head | 116,243 head | 4.5 | 5,230 head |
| Milk | 327,429,705 lbs. | | 327,429,705 lbs. | 4.5 | 14,734,300 lbs. |
| Butterfat in cream | 57 lbs. | | 57 lbs. | 4.5 | 0 lbs. |

1 Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 3-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (Dollars) | Adjustment Factor[1] | Adjusted Value of Sales (Dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (Dollars) |
|---|---|---|---|---|---|
| Dairy Products | 13,898,000 | 1.051 | 14,606,798 | 4.5 | 657,300 |
| Cattle and Calves | 2,202,000 | 1.051 | 2,314,302 | 4.5 | 104,100 |
| Total | | | | | 761,400 |
| Rounded | | | | | 761,000 |

1 Prices received—Livestock and Livestock products.

2 Rounded. $\frac{\text{Long-term adjusted normalized index}}{\text{1984 Index}} = \frac{247}{235} = 1.051$

PHOTO 3-7. Irrigating corn east of Ferndale. (USBR photo)

PHOTO 3-8. Raspberries being irrigated east of Blaine. (USBR photo)

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Nooksack-Sumas Basins total 148,910 acres, of which 38,400 are presently irrigated and 110,510 are potentially irrigable. The lands are on upland glacial hills, intermediate terraces, and recent alluvial bottoms along the Nooksack River and other local streams. It is expected that there will be a total of about 78,000 acres under irrigation in the Basins by the year 2020.

PHOTO 3-9. Potentially irrigable lands in the vicinity of Ferndale. Lake Terrell at right center. Mount Baker in background. (USBR photo)

### Land Characteristics

Soils within the Basins have developed under the influence of humid climate and moderate temperature. Surface soil textures are generally medium to fine, of medium grade structure, and friable. Subsoils generally have medium grade, subangular, blocky structure which ranges from friable to firm. The occurrence of water stable aggregates or granules in the soil allows free movement of water through the soil while maintaining a desirable moisture holding capacity. Natural fertility is moderate to high but addition of fertilizers gives favorable economic returns.

Recent alluvial bottom and terrace lands are suited to the production of all crops adapted to the climate of the area, which includes grass and legumes for pasture, strawberries, raspberries, potatoes, alfalfa, and vegetable crops. Local soil and drainage conditions may limit production to specialized crops in some areas. The higher-lying, hilly, glacial lands are best suited to production of pasture crops. However, some of the adapted general farm crops could be grown on these lands.

In general, the potentially irrigable lands are well suited to irrigation by sprinkler application. About 20% have some degree of topographic deficiency. A majority of these have slopes of less than 10%, a relatively small part have slopes between 10 and 20% in general gradient.

About 65,000 acres of the potentially irrigable lands have varying degrees of drainage problems. On the glacial upland soils the deficiency is primarily internal, and sprinkler application would be the practicable method on these lands. Most of the potentially irrigable lands with drainage problems could be improved by construction of shallow surface drains, and improvement of natural channels for removal of heavy winter precipitation.

### Land Classes

Potentially irrigable lands in the Nooksack-Sumas Basins total 110,510 acres, of which 19,360 acres are in woodlands. The following tabulation shows the acreage distribution of potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 2,910 | 820 | 3,730 |
| 2 | 36,570 | 4,960 | 41,530 |
| 3 | 51,670 | 13,580 | 65,250 |
| Total | 91,150 | 19,360 | 110,510 |

These lands are shown on Figure 3-2.

## PROJECTION OF FUTURE IRRIGATION

Expectations are that about 40,000 acres of new lands, primarily in the valley below Deming, eventually will be under irrigation. Estimates indicate that 20,000 acres will be irrigated by 1980, and the remaining 20,000 acres by the year 2000. Projected irrigation development to 1980 is expected to follow present trends whereby additional farm units are placed under irrigation each year. The units will be scattered throughout the Basins, and development will be primarily by private means. Since an abundant supply of ground water exists in most lowland areas, it is anticipated that this will be the source of supply for the 20,000 acres expected to be irrigated by 1980.

Present and Future water demands are:

| Year | New Irrigation (acres) | Supply Source GW (acres) | Supply Source SW (acres) | Surface Diversions Annual (ac.ft.) | Surface Diversions Peak (cfs) |
|---|---|---|---|---|---|
| Present | --- | 23,000 | 15,400 | 29,000 | 200 |
| 1980 | 20,000 | 18,000 | 2,000 | 4,000 | 25 |
| 2000 | 20,000 | --- | 20,000 | 38,000 | 250 |
| 2020 | --- | --- | --- | --- | --- |

Maximum irrigation requirements for the Basins are:

| | |
|---|---|
| Peak farm delivery requirement | 79 acres/cfs |
| Farm delivery requirement | 1.81 acre-feet/acre |
| Diversion requirement | 1.91 acre-feet/acre |

The monthly distribution of the irrigation requirements are shown as percent of the annual demand.

| | | | |
|---|---|---|---|
| June | 22% | August | 28% |
| July | 37% | September | 13% |
| | | Total | 100% |

# MEANS TO SATISFY NEEDS

Streamflow records indicated there is adequate water supplies in the Nooksack River to meet the future irrigation needs. Those lands with adequate ground water supplies and relatively inexpensive access to surface supplies likely will have been developed by 1980. The 20,000 acres projected to be developed between the years 1980 and 2000 could possibly be irrigated through project-type developments using Nooksack River flows. The areas appearing most favorable for development at this time are located around Lake Terrell, south of Tenmile Creek, and northeast of Lynden. These areas could be served by pumping from the Nooksack River through pipe distribution systems.

To determine the relative economics of irrigating some of the potentially irrigable lands, cost estimates were made of a typical project-type irrigation system. Also, the farmer's additional gross income value resulting from irrigation was determined.

The estimate is based on pumping from the Nooksack River into a buried pipe distribution system to provide water to the lands by sprinkler application. Long discharge lines and relatively high pump lifts would be necessary to serve the potentially irrigable lands lying at the higher elevations away from the river.

The total investment cost for this type of system would be about $1,000 per acre. Annual operation and maintenance costs would range from $9 to $13 per acre. These operating costs include power, operation, maintenance and replacement costs. If upstream storage is required to meet the water supply needs, additional costs would be involved. Also there would be a cost for the individual farm sprinkler system which is not included in the project costs.

The projected investment costs for the Nooksack-Sumas Basins are shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $2,700,000 | -- |
| 1980-2000 | $2,200,000 | $20,000,000 |
| 2000-2020 | -- | -- |

| Year | New Irrigation (acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | 20,000 | $1,920,000 |
| 2000 | 20,000 | $1,920,000 |
| 2020 | -- | -- |

For the 1980 level of development the annual operating costs are estimated to be $220,000. The cost of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $96 per acre and is summarized as follows:

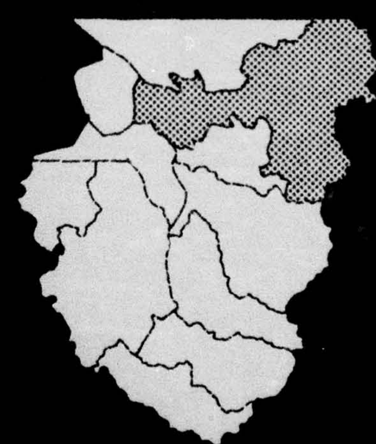
The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in the Puget Sound Area under Means to Satisfy Needs.

Estimated net depletions of surface and ground water sources associated with present and anticipated irrigation development are shown below:

| Year | New Irrigation (acres) | Net Depletion[1] GW (ac.ft.) | Net Depletion[1] SW (ac.ft.) | Total Accumulated Depletion (ac.ft.) |
|---|---|---|---|---|
| Present | ---- | 30,000 | 20,000 | 50,000 |
| 1980 | 20,000 | 23,000 | 3,000 | 76,000 |
| 2000 | 20,000 | --- | 26,000 | 102,000 |
| 2020 | ---- | ---- | ---- | 102,000 |

[1] Diversion requirement minus return flow.

# Skagit-Samish Basins



# SKAGIT-SAMISH BASINS

The Skagit-Samish Basins cover about 3,184 square miles between the Nooksack-Sumas Basins and Canada on the north to the Stillaguamish and Snohomish Basins on the south, and easterly from Puget Sound to the crest of the Cascade Range. Major features include the Skagit River, Samish River, several small streams and a number of offshore islands.

The Skagit River, with its source in British Columbia, is the largest stream in the Puget Sound Area. The upper reaches of the Skagit River Basin are characterized by steep, rugged, alpine mountains, tumbling streams and narrow valleys which merge and gradually broaden out into a large glacial outwash plain near Sedro Woolley. Below Sedro Woolley the river meanders for several miles before it separates into two distinct branches and empties into Skagit Bay. The Samish River, second largest stream in the Basins, and its tributary Friday Creek originate in the mountainous area south of Bellingham and drain into Samish Bay.

The climate of the area is characterized by cool summers, mild winters, and high annual rainfall. Average annual precipitation increases from the coast inland due to the orographic effect of increasing elevations. The Basins receive about 75 percent of their annual precipitation during the period October through March. Average temperatures near the Puget Sound are 40°F in the winter and 62°F in the summer.

Virgin vegetation was predominantly large conifers, and today woodlands cover about 90 percent of the land area. Croplands are located primarily on the rich alluvial lowlands with the extensive timber lands in the higher mountainous areas.

The alluvial plain of the Skagit River consists of clay, silt, and fine sand in various proportions laid down by overflow of the river. Natural drainage characteristics of the silt loams and sandy soils are generally good, while those of the finer textured soils are somewhat restricted. These soils are very fertile.

The following tabulation indicates land use in the Basins.

| | Acres |
|---|---|
| Cropland | 100,000 |
| Rangeland | 20,000 |
| Forest | 1,754,000 |
| Rural nonagricultural | 20,000 |
| Built-up areas | 19,000 |
| Total | 1,913,000 |

Settlement and development has progressed most rapidly in the river valleys and in the broad delta areas at the mouths of the Skagit and Samish Rivers. Since the earliest settlement, lumbering has been one of the most important elements of the economy. Anacortes is one of the leading fish and seafood processing centers in the State. Limestone is an important industrial material in the area, supporting a large cement plant at Concrete. Most of the agricultural enterprises are along the Skagit River bottom lands and alluvial plain. Dairy farms far outnumber all other types with a large part of the cropped land in hay, vegetables and small grains. The pea industry is a large contributor to the Nation's fresh frozen supply, and the high-quality strawberries provide a substantial share of the total farm income. Recreational resources in the Basins are substantial with opportunities for camping, fishing, hiking, swimming, hunting, sailing, winter sports, and scenic attractions.

The present population of the Basins is about 56,900 with over half rural. Principal urban sites are Anacortes, Mt. Vernon, Sedro Woolley, and Burlington. Anacortes with a population of 8,630 in 1966 is the only saltwater port.

Contributing growth factors for the Basins' economy have been the increase in row cropping and related food processing, ship building activity in Anacortes, and construction of two oil refineries and a chemical plant at Anacortes.

# PRESENT STATUS

Irrigation development in the Skagit-Samish Basins has been slow but constant with the greater portion located along the Skagit River and on its alluvial plain.

As in most of the Puget Sound Area, irrigation here varies from year to year depending upon the amount of precipitation received during the growing season. In 1965, about 6,200 acres were irrigated in the Basins and this is considered to be the acreage normally irrigated. The relationship between crop consumptive use, effective precipitation, and irrigation requirements is illustrated in Figure 4-1.

## IRRIGATED LANDS

Presently irrigated lands are located along the Skagit River from the community of Concrete to the river mouth, and on the large fanshaped delta plain west of Sedro Woolley.

In the irrigated areas soil surface textures range from loamy sands to silty clay loams with most of the irrigated acreage located on soils that are either coarse or fine textured. Most of the soils have an open permeable substrata.

Topography of the lands under irrigation is nearly level to slightly undulating. Only about 250 acres of the irrigated lands have uneven surface relief or slopes of over 8 percent in gradient.

Presently irrigated lands in the Skagit-Samish Basins were classified as classes 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 4-2. A summary of the lands irrigated in 1965 is shown below.

| Land Class | Irrigated (Acres) |
|---|---|
| 1 | 500 |
| 2 | 4,900 |
| 3 | 800 |
| Total | 6,200 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

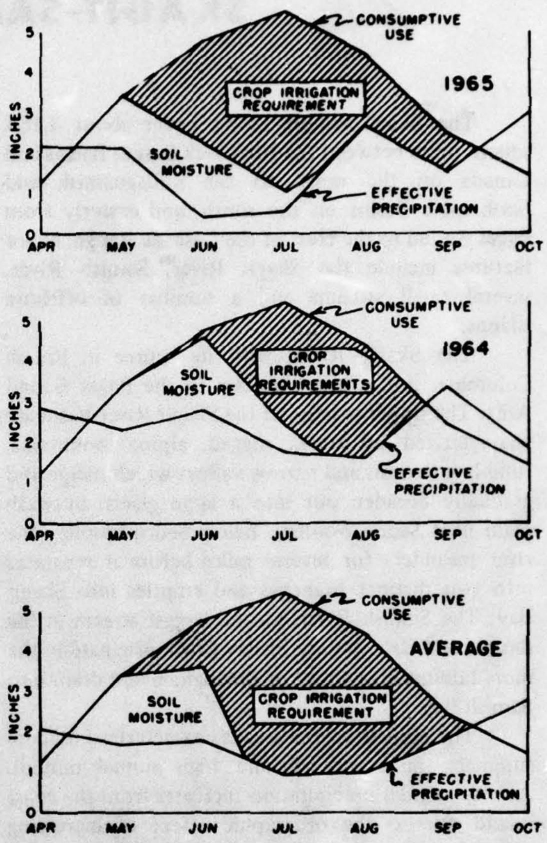



FIGURE 4-1. Crop irrigation requirements for typical dry, wet, and average years.

## WATER RESOURCES

### Water Supply

Water supply for the irrigated lands is obtained primarily from wells. Minor diversions from the Skagit River, Samish River and their tributaries make up the remaining supply. Nearly 70 percent of the land receives its water supply from ground water and the remaining 30 percent is supplied from surface sources.

The Skagit River has the largest runoff of the drainage basins in the Puget Sound Area, averaging about 12 million acre-feet annually at Mt. Vernon. About 7 million acre-feet or 60 percent of the total runoff occurs during April-October as shown in Table 4-1. High runoff occurs in two periods; December and

Bellingham
SAMISH
RIVER
MT VERNON AIRPORT
BURLINGTON
SEDRO WOOLLEY
SKAGIT
MT. VERNON
5
Marysville
Sca
2
1967

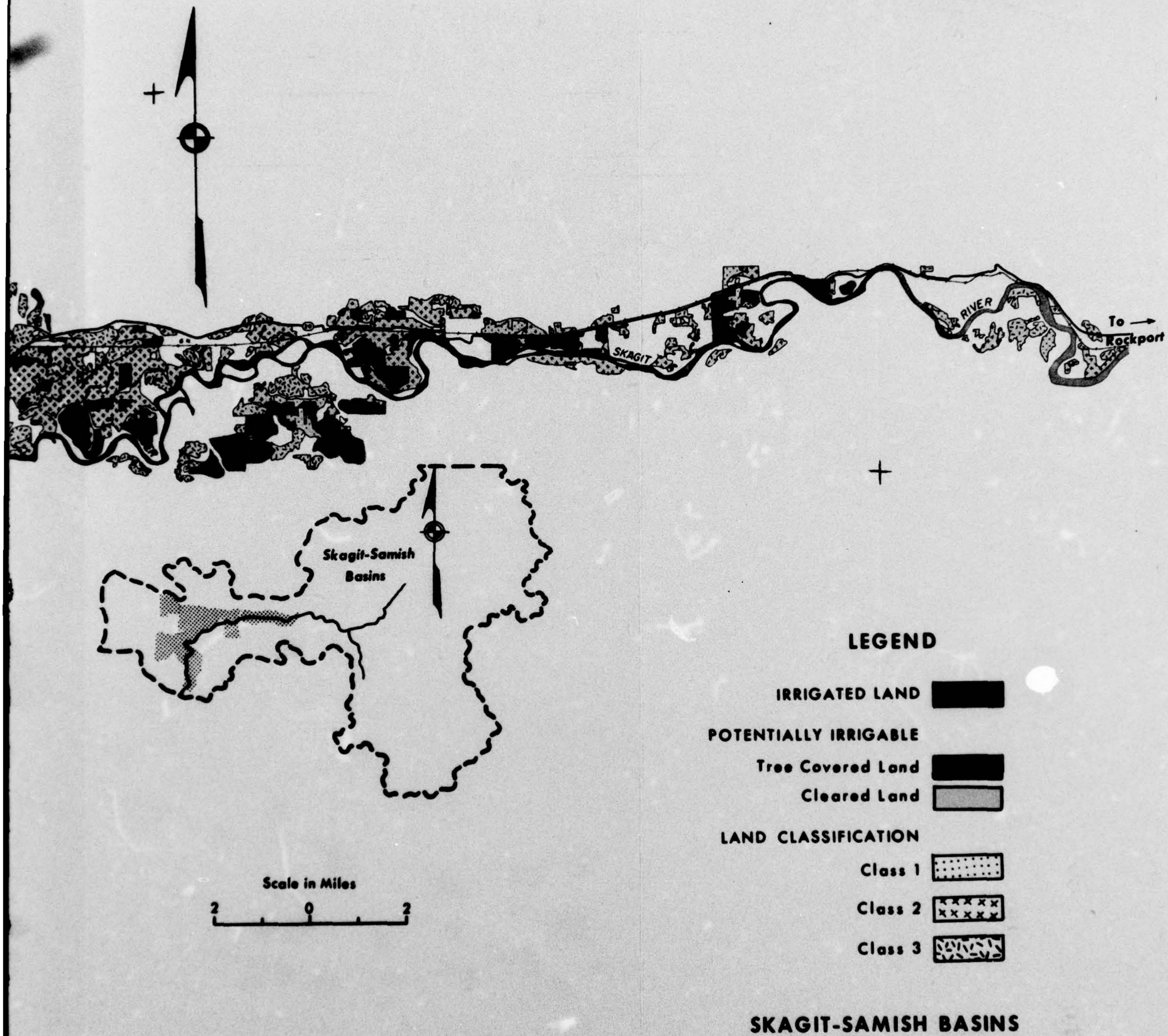



FIGURE 4-2 Irrigation, Skagit-Samish Basins



2

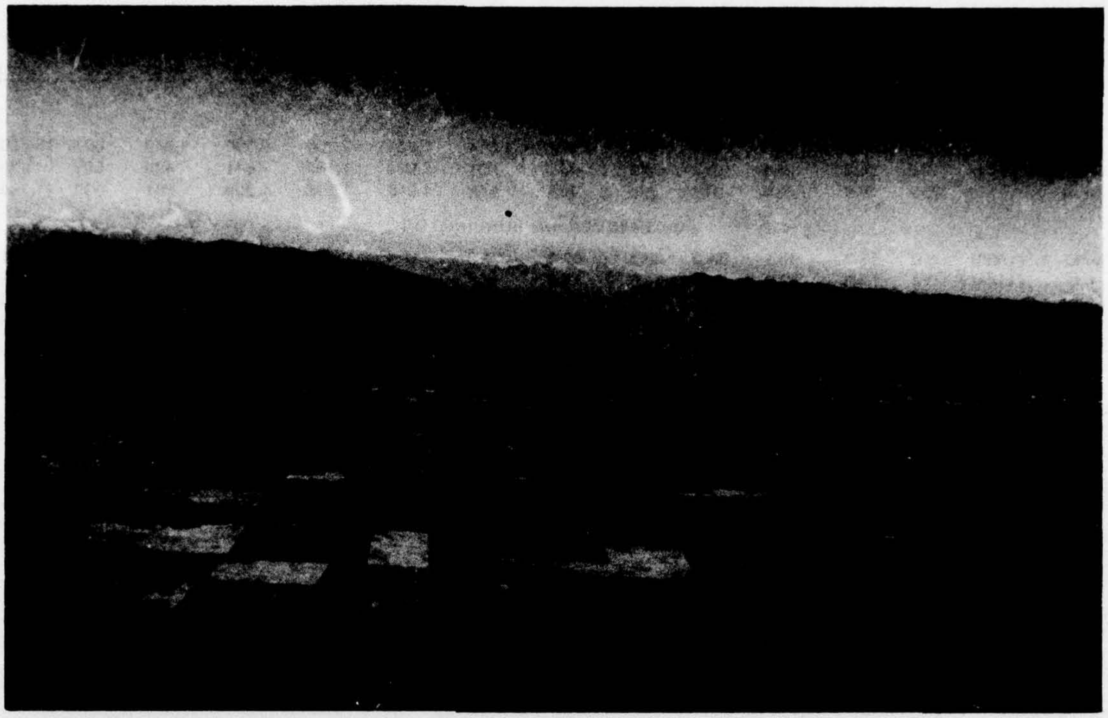


PHOTO 4-1. Skagit-Samish alluvial plain. Burlington is at the right with Sedro Woolley in center background. *(USBR photo)*

June, while minimum runoff generally occurs in late September or early October. Adequate water is available from the Skagit River Basin to supply present irrigation diversions. Glaciers and reservoirs in the upper Skagit River Basin have the effect of regulating streamflows by practically eliminating the occurrence of low flows during the dry summer months.

PHOTO 4-2. Typical agricultural area near Sedro Woolley. (USBR photo)

The Samish River, as shown in Table 4-1, has a streamflow pattern characterized by high runoff in the winter months and a low flow period in August and September. The runoff is primarily from rainfall. Flows of the low altitude streams or their tributaries will occasionally drop to where shortages can occur, especially in the streams which are heavily appropriated.

Surface water is of good quality as evidenced by analysis of samples taken and by the fact that it has been used for irrigation for about 30 years with no apparent harmful effects to soils or to crops grown. High sediment rates in the area are associated with periods of high runoff. Irrigators have not experienced extensive sedimentation problems from the use of Skagit River water although the potential problem exists. Diversions from the low altitude streams such as the Samish River or Nookachamps Creek experience very little sediment problem during the irrigation season. Glacial flour, which is nearly always present in the Skagit River, has little effect on the use of the water for irrigation.

**TABLE 4-1. Monthly and annual runoff—1000's of acre-feet (period: 1931-1960)**

| | Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SKAGIT RIVER near MT. VERNON | | | | | | | |
| Max. | (1950) | 797 | 1,412 | 1,342 | 967 | 1,096 | 1,402 | 1,054 | 1,364 | 2,256 | 2,196 | 1,049 | 607 | 15,520 |
| Min. | (1944) | 498 | 392 | 656 | 613 | 463 | 484 | 631 | 1,070 | 1,167 | 641 | 420 | 592 | 7,630 |
| Mean | | 764 | 956 | 1,069 | 918 | 762 | 768 | 958 | 1,516 | 1,638 | 1,229 | 661 | 539 | 11,780 |
| | | | | | | | SAMISH RIVER near BURLINGTON | | | | | | | |
| Max. | (1950) | 6.9 | 15.7 | 49.1 | 34.2 | 38.1 | 42.9 | 27.9 | 12.4 | 6.1 | 2.8 | 2.3 | 2.0 | 241 |
| Min. | (1944) | 3.4 | 3.8 | 13.6 | 14.3 | 14.6 | 12.5 | 9.0 | 7.7 | 4.8 | 1.7 | 1.5 | 2.6 | 89 |
| Mean | * | 9.7 | 20.0 | 28.3 | 28.8 | 26.1 | 22.1 | 16.9 | 10.5 | 5.9 | 3.2 | 2.3 | 2.7 | 176 |

*Average during period 1943-60.

Most of the ground water used for irrigation is located in the central and eastern part of the alluvial plain. The plain consists of loamy sands and silty clay loams laid down by the overflow of the river. Ground water is at relatively shallow depths and some wells produce over 500 gallons per minute.

The ground water supply in the upper Skagit River Basin (east of Sedro Woolley) is limited due to the close proximity of bedrock to the surface. Ground water in the western extremity of the alluvial plain generally produces low yields and tends to be brackish.

Although more highly mineralized than surface water, ground water is of adequate quality for irrigation. High conductivity is evidenced at several wells because they obtain water from older marine sedimentary deposits. Iron is also an objectionable constituent in some of the ground waters of the area. Ground water generally increased in salinity from Sedro Woolley toward the bay areas. Generally, irrigation from wells in the Skagit Basin has been practiced many years with no apparent harmful effects to soils or crops.

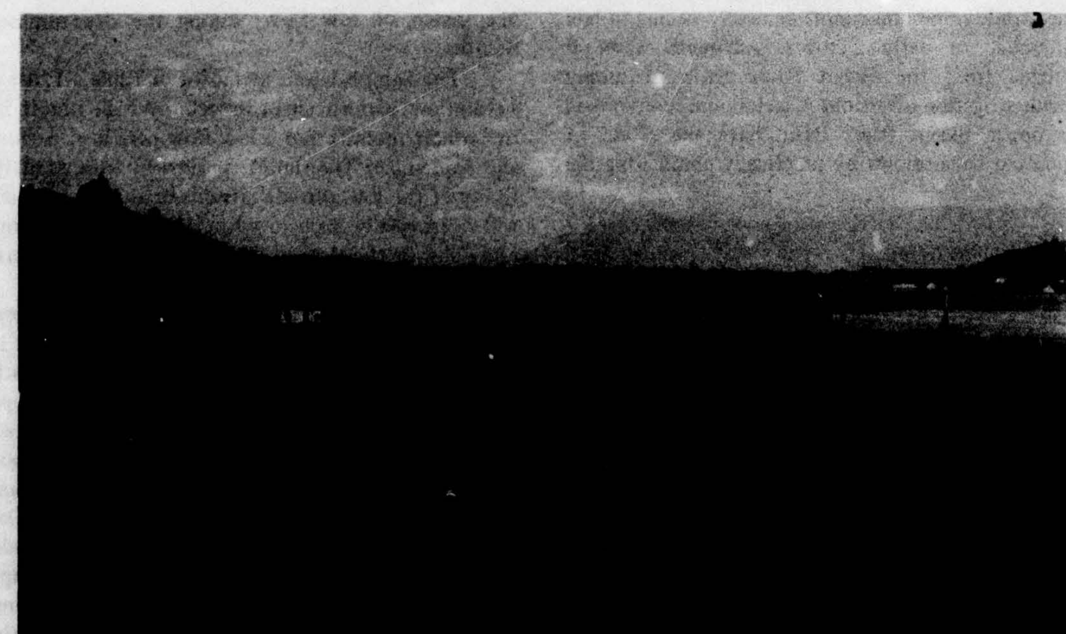


PHOTO 4-3. Typical level topography of farmlands west of Sedro Woolley. (USBR photo)

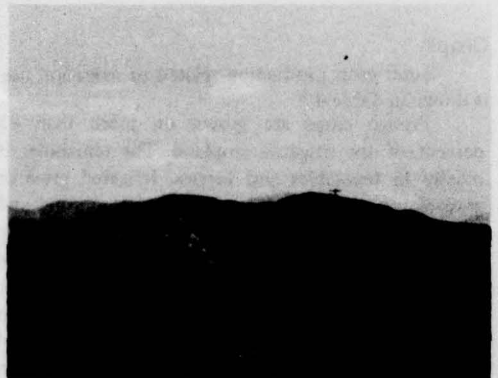


PHOTO 4-4. Irrigating pasture from ground water near Sedro Woolley (USBR photo)

### Water Rights

There has been no adjudication of water rights in the Skagit-Samish Basins. As of April 30, 1967, there were 4,400 acres in the Basins which had a permit or a certificate for a surface water right. The total maximum diversion to serve this acreage is about 48 cubic feet per second. Ground water irrigation rights as of September 30, 1966, total about 74 cubic feet per second for 6,300 acres.

### Water Requirements

Irrigation requirements for the Skagit-Samish Basins have been estimated using climatological data from the Sedro Woolley and Anacortes stations. Average precipitation for the months of June, July and August totals about four inches. Less than one inch falls in July.

Annual consumptive use of irrigated crops is estimated at 1.93 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.75 acre-foot per acre in a dry year. The consumptive use to be met by irrigation would be about 1.18 acre-feet per acre. With an estimated farm irrigation efficiency of 65 percent, a farm delivery requirement of 1.82 acre-feet per acre would be required.

Using this farm delivery requirement, and an estimated operational loss and waste of 5 percent of the diverted amount, the presently irrigated lands (6,200 acres) require an average annual diversion of about 12,000 acre-feet.

Monthly irrigation requirements during the growing season are shown in Table 4-2.

TABLE 4-2. Irrigation requirements

| | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|
| Distribution | 18% | 37% | 30% | 15% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .22 | .43 | .35 | .18 | 1.18 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .34 | .66 | .55 | .27 | 1.82 |
| Diversion Requirements (Acre-Feet/Acre) | .35 | .71 | .58 | .28 | 1.92 |

Return Flows from much of the land in the Skagit River lowlands are collected in extensive drainage systems which discharge directly into Puget Sound. Consequently, a very small portion of return flows are available for re-use. Estimates of the annual net usable return flow of the irrigated lands are about 500 acre-feet resulting in an 11,500 acre-foot annual depletion of ground and surface waters.

### Adequacy of Supply

With few exceptions, the quantity of the waters of the Skagit-Samish Basins are adequate to meet the *present irrigation needs of the area.* Some areas, primarily along the upper Skagit River and along the western portion of the delta plain, are deficient in ground water. Sufficient surface water is not available on some of the highly-appropriated small tributaries.

PHOTO 4-5. Irrigating during the dry summer months. (USBR photo)

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $199,000 from increased crop production and $219,000 from increased production of livestock and livestock products for a total value of $418,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964 and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livstock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 1,625 farms in the Skagit-Samish Basins; only 55, or about three percent, had irrigated cropland in 1964. As shown in Table 4-3, dairy and other livestock farms are the most common farming enterprises in the Basins identified by source of farm income.

The average size of commercial farms is about 130 acres and farms with irrigated cropland average nearly 150 acres. Commercial farms with milk cows average about 43 cows per farm.

**TABLE 4-3. Farm Types—1964[1]**

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crop | 10 | .6 |
| Vegetable | 120 | 7.4 |
| Fruit and Nut | 65 | 4.0 |
| Poultry | 40 | 2.5 |
| Dairy | 340 | 20.9 |
| Other Livestock | 135 | 8.3 |
| General | 45 | 2.8 |
| Miscellaneous | 870 | 53.5 |
| Total | 1,625 | 100.0 |

[1]Estimated from Census of Agriculture.
[2]Rounded to the nearest 5.

### Crops

Total crop production related to irrigation use is shown in Table 4-4.

Forage crops are grown on more than 85 percent of the irrigated cropland. The remainder is mostly in vegetables and berries. Irrigated grass or grass-clover crops are processed by dehydrating and pelleting, harvested as hay, or grazed. The early crop is generally cut in May for silage or green feed as the weather is too wet to make hay or graze. Later in the season, this cropland is irrigated and is harvested as hay or is grazed, although some is cut for green feed all season. Almost all of the hay, silage and green chop feed is used within the Basins. Grass that is dehydrated is harvested by green chop methods throughout the season and is made into pellets which are used in making poultry feed for use throughout the Pacific Northwest.

Sweet corn, broccoli, cucumbers, and cauliflower, are commercially important vegetables that are irrigated. Other vegetables grown commercially in the Basins generally are not irrigated. Most vegetables go to processors in and near the Basins.

Irrigated strawberries and raspberries are grown commercially and are sold primarily to frozen food processors.

**TABLE 4-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre[1] | Total[2] |
|---|---|---|---|---|
| Field Crops | | | | |
| Potatoes | 130 | Ton | 4.50 | 580 |
| Forages | 5,390 | | — | — |
| Hay | (2,150) | Ton | 1.01 | 2,170 |
| Pasture | (2,240) | AUM | 2.40 | 5,380 |
| For Dehydrating | (1,000) | Ton | 2.97 | 2,970 |
| Vegetables | 400 | Ton | 1.75 | 770 |
| Sweet Corn | (90) | Ton | (2.00) | (180) |
| Broccoli | (70) | Ton | (3.40) | (240) |
| Cucumbers | (40) | Ton | (3.22) | (130) |
| Cauliflower | (40) | Ton | (3.13) | (120) |
| Green Peas | (200) | Ton | (.50) | (100) |
| Berries | 240 | Ton | 1.50 | 360 |
| Strawberries | (220) | Ton | (1.56) | (340) |
| Raspberries | (20) | Ton | (1.13) | (20) |
| Total | 6,200 | | | |

[1]See the Puget Sound Area for method of derivation.
[2]Rounded to the nearest 10.

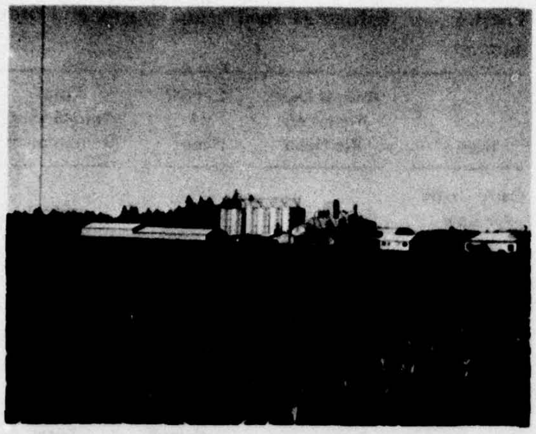


PHOTO 4-6. Grass dehydrator north of Mt. Vernon. (USBR photo)

PHOTO 4-7. Picking strawberries west of Mt. Vernon. (USBR photo)

Potatoes are the only field crop irrigated in the Basins. Some are sold for use locally and throughout the Puget Sound Area, but most are shipped to markets in California and Texas.

## Crop Values

Crop values related to irrigation are shown in *Table 4-5.*

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises and meat packing and dairy processing plants are located in the Basins. The derivation of estimated animal units of feed requirements and production is shown in Table 4-6.

The increased production from irrigated cropland *used to produce forage in support of livestock*

**TABLE 4-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value Per Unit[1] (dollars) | Value Total (dollars) |
|---|---|---|---|---|
| Field Crops | Ton | 580 | 22 | 12,800[3] |
| Forages | | | | |
| Hay | Ton | 2,170 | ---- | ---- [2] |
| Pasture | AUM | 5,380 | ---- | ---- [2] |
| For Dehydrating | Ton | 2,970 | 8 | 23,800[3] |
| Vegetables | Ton | 770 | 85 | 65,400[3] |
| Berries | Ton | 360 | 270 | 97,200 |
| Total | | | | 199,200 |
| Rounded | | | | 199,200 |

[1] Weighted average prices received—adjusted normalized basis.

| | |
|---|---|
| Broccoli | $130/Ton |
| Cauliflower | $ 99/Ton |
| Sweet Corn | $ 26/[illegible] |
| Cucumbers | $ 63/Ton |
| Green Peas | $ 93/Ton |
| Strawberries | $270/Ton |
| Raspberries | $330/Ton |

[2] Values accounted for in livestock and livestock product values.

[3] Rounded to the nearest $100.

PHOTO 4-8. Young strawberry plants east of Sedro Woolley. (USBR photo)

enterprises provides about 2.1 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrients (T.D.N.) requirement is shown in Table 4-7. The production is based on 2.1 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 4-6.

In terms of T.D.N.'s only, the full feed requirements of about 1,550 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all their feed. In reality, the nutritional requirements of many more than 1,550 head of cattle are partially satisfied by irrigated feeds.

**TABLE 4-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 18,090 | 30,210 |
| Per Feeder | .58 | 4,390 | 2,546 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 6,270 | 7,963 |
| Per Feeder | .38 | 5,070 | 1,927 |
| Total | | | 42,646 |
| Rounded | | | 42,600 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grains | | | |
| Hay—Ton | 2,170 | .20 | 434 |
| Pasture—AUM | 5,380 | .08 | 430 |
| Total | | | 864 |
| Rounded | | | 900 |

[1]Rounded to the nearest 10 head.
[2]Includes feed required for replacements, bulls and young stock normally associated with the breeding herd.
[3]Animal Units of feed per ton/AUM.

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 4-8. The value estimates are based on the proportion of feed attributable to irrigation.

**TABLE 4-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 24,541 head | 49,240 head | 73,781 head | 2.1 | 1,550 head |
| Milk | 173,269,731 lbs. | --- | 173,269,731 lbs. | 2.1 | 3,638,700 lbs. |
| Butterfat in cream | 85,851 lbs. | | 85,851 lbs. | 2.1 | 1,800 lbs. |

[1]Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 4-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 7,729,800 | 1.051 | 8,124,020 | 2.1 | 170,600 |
| Cattle and Calves | 2,195,300 | 1.051 | 2,307,260 | 2.1 | 48,500 |
| Total | | | | | 219,100 |
| Rounded | | | | | 219,000 |

[1] Prices received—Livestock and Livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1984 Index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Skagit-Samish Basins total 95,800 acres, of which 6,200 are presently irrigated and 89,600 are potentially irrigable. Those lands in the Basins exhibiting the best potential for irrigation are in the area upstream from Sedro Woolley and along the Skagit River downstream from Sedro Woolley for some 3 or 4 miles. About 51,000 acres are expected to be under irrigation in the Basins by the year 2020.

### Land Characteristics

The Skagit area consists of an extensive alluvial plain, delta flats, low glacial outwash plains, and smoothly rolling hills. Most of the agricultural lands are on the alluvial plain and recent alluvial soils along the Skagit River. A relatively small part of the potential is located in the upland areas. Elevations of the potentially irrigable lands range from 5 to 200 feet mean sea level. The lands are well suited to sprinkler irrigation.

*The soils of the Basins are of two main groups;* bottom land or alluvial soils and upland soils. In general the bottom land soils are fertile, highly productive, and have many different agricultural uses. The upland soils in general are much less fertile and, therefore, are less productive.

*The alluvial soils are the most important agri*cultural soils and make up the greatest percentage of the potentially irrigable lands. They have a wide adaptability to all crops grown in the Basins. The principal areas of these soils are along the Skagit River between Concrete and Sedro Woolley, and on the delta plain between Sedro Woolley and Puget Sound. The delta plain is about 20 miles wide at the coast and includes the lower Samish River valley on the north and joins the Stillaguamish delta plain just south of the Skagit County line on the south. Small fingers of alluvial soils protrude 3 to 4 miles up the narrow Samish River valley to the north, and south along the Nookachamps valley and in the vicinity of Clear Lake and Beaver Lake. There are some alluvial soils farther up the Skagit Valley above Concrete but they are isolated into small scattered patches and were not classified as a part of this study.

There are five general locations of the upland and terrace soils: (1) large plateau-like areas bordering the delta plain on the north from Sedro Woolley to Samish Bay; (2) Bay View Ridge, a 14-square-mile monadnock between the Samish and Skagit Rivers and bordered by Padilla Bay on the west; (3) a 12 to 13 square-mile area east of Mount Vernon and south of Sedro Woolley; (4) an area of about 12 square-miles south of Mount Vernon; and, (5) terraces

overlooking the Skagit River Valley from near Sedro Woolley to two miles east of Concrete.

With the exception of the terrace soils east of Sedro Woolley, most of the upland soils are marginal and intermingled with non-irrigable lands. They are mostly glacial soils with cemented, nearly impervious substratas or dense, very slowly permeable clay and clay loam subsoils. The surface soils are often stony or gravelly. Natural fertility is low. These soils are best suited to pasture and hay production. The soils on the terraces upstream from Sedro Woolley have more open profiles and better drainage.

Over 90 percent of the potentially irrigable land is nearly level or slightly undulating. On the alluvial plain, where the largest concentration of cropped land is, the surfaces are mostly smooth with less than one percent slope. In the river valleys there are smooth, 1 to 3 percent slopes, usually tending toward the river. In the upland areas most of the potentially irrigable land is smooth with slopes ranging from 1 to 5 percent.

However, there are some slopes up to 12 percent and some rolling topography. In most places the break between fair to good topography and the steep sloping land is quite abrupt, which results in little marginal topography in the potentially irrigable lands.

Because of the low position of a large part of the Skagit River delta plain in relation to sea level and river level, gravity drainage is difficult. About one-third of the delta is less than 5 feet above sea level and another one-third is 10 feet or less. Although existing drainage facilities are extensive, they are no more than adequate for present farming operations, and may prove to be inadequate with extensive irrigation.

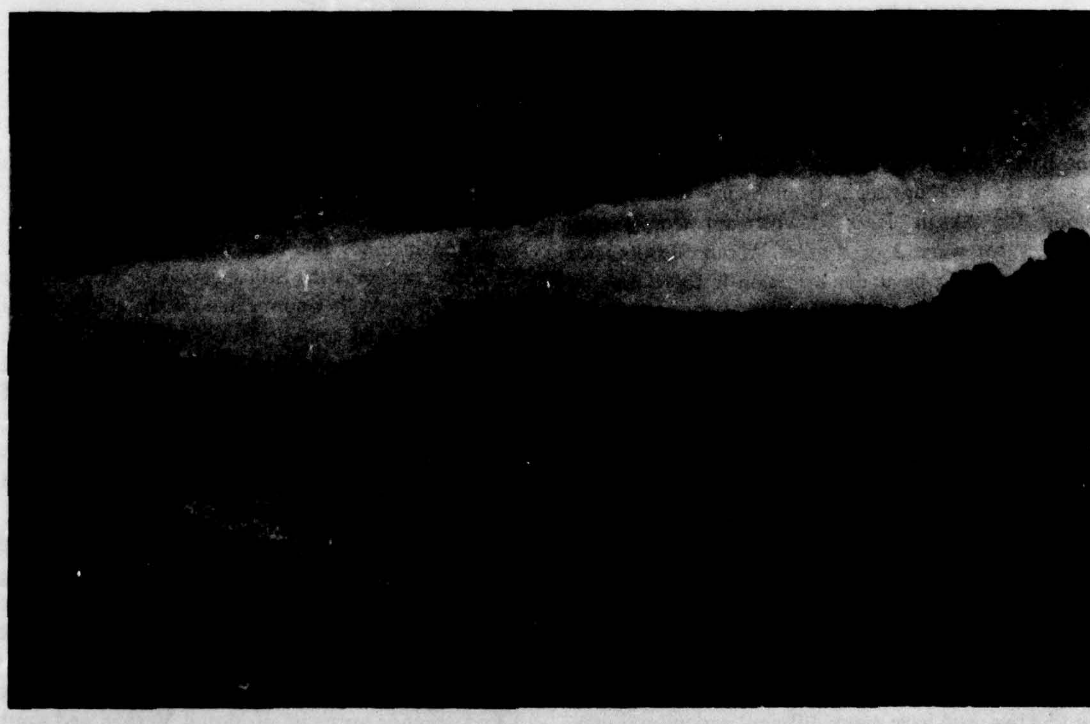


**PHOTO 4-9. Fertile bottom lands such as these are well suited to future irrigation development. (USBR photo)**

**Land Classes**

Potentially irrigable lands total 89,640 acres, of which 8,700 acres are in woodlands. The following tabulation shows the acreage distribution of the potentially irrigable lands by land class:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 2,540 | 100 | 640 |
| 2 | 30,300 | 2,100 | 32,400 |
| 3 | 48,100 | 6,500 | 54,600 |
| Total | 80,940 | 8,700 | 89,640 |

These lands are shown on Figure 4-2.

## PROJECTION OF FUTURE IRRIGATION

Expectations are that about 45,000 acres of new lands will eventually be under irrigation. Present and future irrigation water demands are:

| Year | New Irrigation (acres) | Supply Source GW (acres) | Supply Source SW (acres) | Surface Diversions Annual (ac.ft.) | Surface Diversions Peak (ac.ft.) |
|---|---|---|---|---|---|
| Present | --- | 4,300 | 1,900 | 3,600 | 25 |
| 1980 | 10,000 | 8,000 | 2,000 | 4,000 | 25 |
| 2000 | 10,000 | 5,000 | 5,000 | 10,000 | 65 |
| 2020 | 25,000 | 5,000 | 20,000 | 38,000 | 255 |

Maximum irrigation requirements for the Basins are:

| | |
|---|---|
| Peak farm delivery requirement | 79 acres/cfs |
| Annual farm delivery requirement | 1.82 acre-feet/acre |
| Annual diversion requirement | 1.92 acre-feet/acre |

The monthly distribution of the irrigation requirements is shown as percent of the annual demand.

| | |
|---|---|
| June | 18% |
| July | 37% |
| August | 30% |
| September | 15% |
| Total | 100% |

# MEANS TO SATISFY NEEDS

There is an adequate ground and surface water supply in the Basins to meet the projected irrigation water needs.

Irrigation development is not extensive in the Skagit-Samish Basins and the potential for project-type development is excellent. Development of irrigation by private means will likely continue through 1980. After 1980, irrigation development could be accomplished by pumping from the Skagit River through project distribution systems. For any extensive irrigation development there will need to be some type of conveyance system that will provide the farmers with an adequate water supply.

To determine the relative economics of irrigating some of the potentially irrigable lands, cost estimates were made of a typical project-type irrigation system. Also, the farmer's additional annual gross income resulting from irrigation was determined.

The estimate for the project system is based on pumping from the Skagit River into a buried pipe distribution system to provide water to the lands by sprinkler application. Potentially irrigable lands in the Skagit-Samish Basins are generally low lying and within a short distance of the Skagit River resulting in a comparatively low pump lift to provide adequate pressure to the individual farm turnouts.

The total investment cost for this type of system would be about $600 per acre. Annual operation and maintenance costs would range from $8 to $9 per acre. These operating costs include power, operation, maintenance and replacement costs. Streamflow records indicate that there is adequate water in the river to meet the future irrigation needs of the Basin. However, when other needs of the Basin are considered, storage may be required to meet these needs. If upstream storage is required to meet the water supply needs, additional

costs would be involved. Also, there would be a cost for the individual farm sprinkler system which is not included in the project cost. The projected investment costs for the Skagit-Samish Basins are shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $1,350,000 | -- |
| 1980-2000 | $1,100,000 | $ 6,000,000 |
| 2000-2020 | $2,750,000 | $15,000,000 |

For the 1980 level of development the annual operating costs are estimated to be $90,000. Costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $70 per acre and is summarized as follows:

| Year | New Irrigation (acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | 10,000 | $ 700,000 |
| 2000 | 10,000 | 700,000 |
| 2020 | 25,000 | 1,750,000 |

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in the Puget Sound Area.

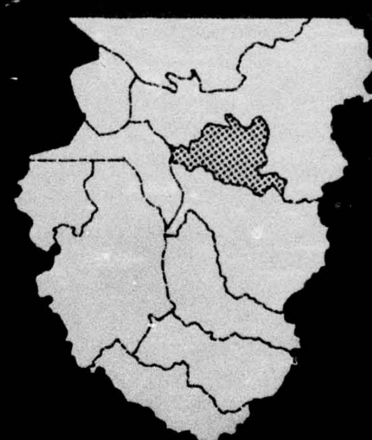
Return flows from presently irrigated lands are now collected in a drainage network which discharges directly into the Puget Sound. Under future conditions, the drainage is expected to be collected and discharged in the same manner. Thus, little return flow will actually return to the Skagit or Samish Rivers.

Estimated net depletions of surface and ground water sources associated with present and anticipated irrigation development in the Basins are shown below:

| Year | New Irrigation (acres) | Net Depletion[1] GW (ac.ft.) | SW (ac.ft.) | Total Accumulated (ac.ft.) |
|---|---|---|---|---|
| Present | ---- | 8,000 | 3,500 | 11,500 |
| 1980 | 10,000 | 14,900 | 3,700 | 30,100 |
| 2000 | 10,000 | 9,300 | 9,300 | 48,700 |
| 2020 | 25,000 | 9,300 | 37,200 | 95,200 |

[1] Diversion requirement minus return flow.

# Stillaguamish Basin



# STILLAGUAMISH BASIN

The Stillaguamish Basin lies largely in Snohomish County but also contains a portion of Skagit County. It is one of the smaller basins of the Puget Sound Area having only 690 square miles of land and water surface area.

The Stillaguamish River originates in the Cascade Mountains at elevations of 4000 to 6000 feet. The two main tributaries, the North Fork and the South Fork, join near Arlington and the main stream meanders approximately 23 miles to enter Puget Sound at Port Susan. The upper reaches are steep mountainous valleys containing turbulent streams and forested lands. Below Arlington the river emerges onto a low alluvial plain with an extensive delta.

Climate in the Basin is similar to the adjacent basins with relatively cool, dry summers and mild winters. Average annual precipitation ranges from about 30 inches at Puget Sound to about 150 inches in the Cascade Mountains. Heavy snow packs occur in the mountains with only one-half square mile of the area in glaciers.

Land use in the Basin is dominated by woodland which accounts for about 90 percent of the total acreage. Most of the cropland is confined to the alluvial lands of the flood plain.

Agriculture and its associated industries account for more than half of the Basin's income. As in the other northern basins, dairy farming is the main agricultural enterprise. As a result most of the cropland is used for hay and silage to support the livestock industry.

The upper reaches of the Basin are in forest lands. Lumber and other forest products are the second most important contributors to the economy of the Basin. Land use in the Basin is as follows:

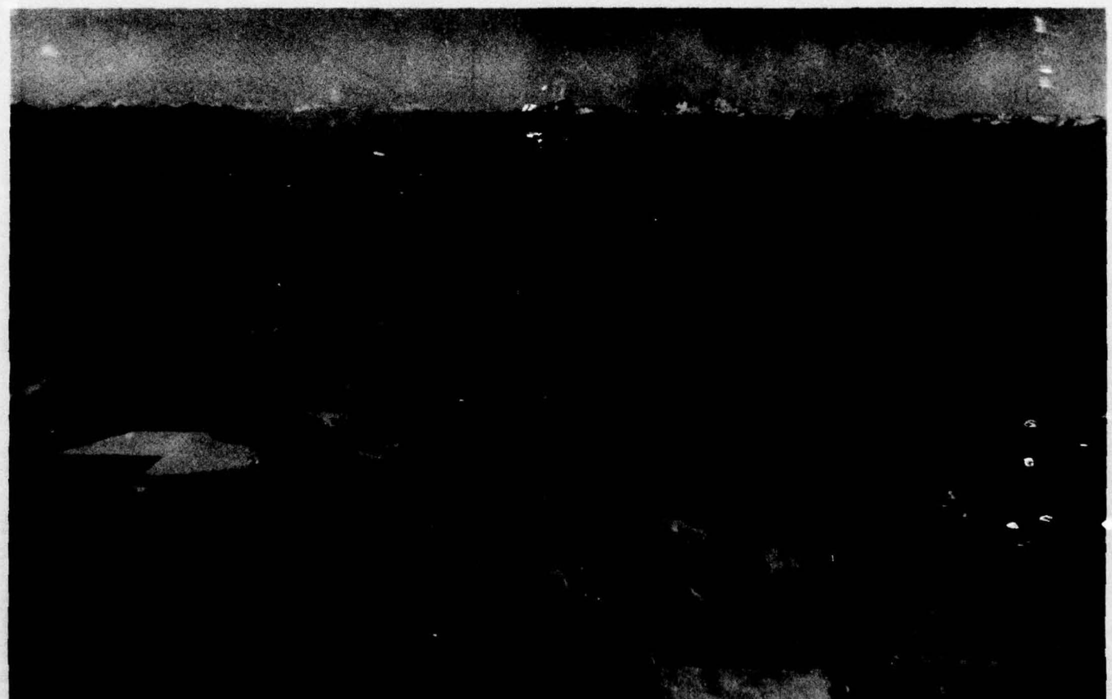


**PHOTO 5-1. General view of Stillaguamish Basin from vicinity of Stanwood eastly towards Arlington. (USBR photo)**

| | Acres |
|---|---|
| Cropland | 35,000 |
| Rangeland | 1,000 |
| Forest | 384,000 |
| Rural nonagricultural | 6,000 |
| Built-up areas | 7,000 |
| Total | 433,000 |

The Basin is located away from large employment centers and has been unable to provide any significant local employment base. Due to the rugged terrain of the eastern part of the Basin, settlement has been sparse. Nearly all settlement is in the bottom lands. Population in the Basin was 15,900 in 1960. Principal cities are Arlington and Stanwood with 1966 populations of 2,148 and 1,235 respectively.

# PRESENT STATUS

Irrigation development has been slowly expanding since 1945. Irrigated acreage varies yearly depending upon growing season precipitation. For example, in 1965, about 2,500 acres were irrigated. However, that year was somewhat dryer than average; the number of acres considered to be normally irrigated is about 2,200. Figure 5-1 illustrates the relationship between crop consumptive use, effective precipitation, and irrigation requirements in the Basin.

## IRRIGATED LANDS

The irrigated lands are located in the lowlands along the Stillaguamish River and, to a lesser extent, in the hilly areas west of Arlington. The irrigated lands occupy areas having a water supply available early in the growing season.

Soils of the irrigated lands are fairly uniform in characteristics and quality. They are generally deep, medium-textured, sandy and gravelly loams.

Topography of most of the irrigated land is nearly level to slightly undulating. Irrigation is predominantly by sprinkler application.

Irrigated lands in the Stillaguamish Basin were classified as Class 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 5-2. A summary of lands irrigated in 1965 is shown below.

| Land Class | Irrigated (Acres) |
|---|---|
| 1 | 1,140 |
| 2 | 1,210 |
| 3 | 180 |
| Total | 2,530 |

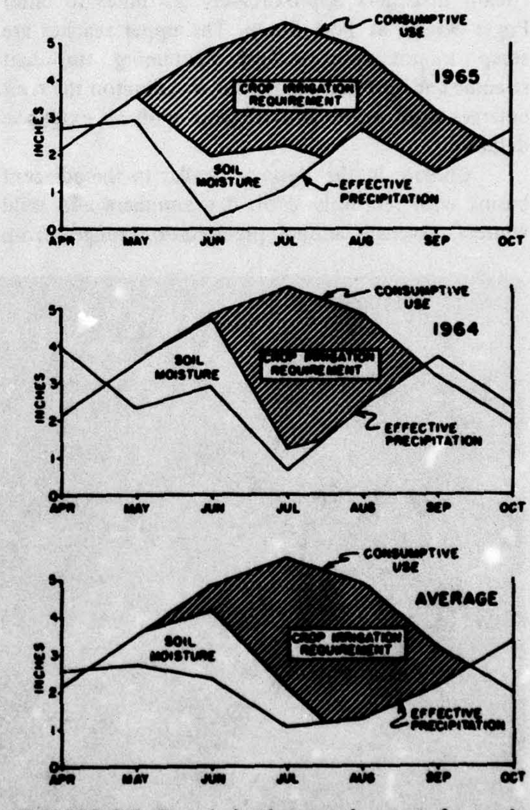



FIGURE 5-1. Crop irrigation requirements for typical dry, wet, and average years.

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

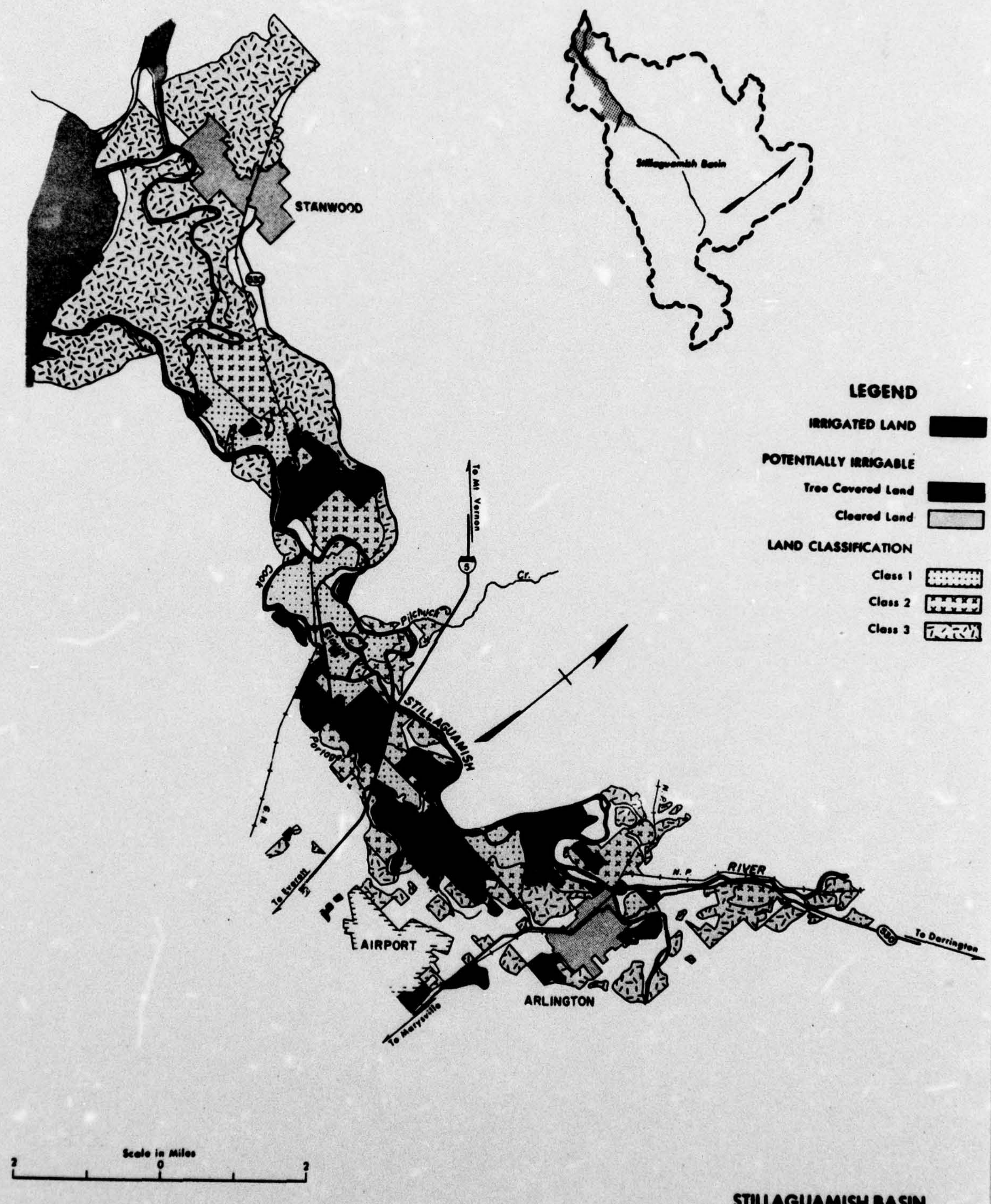



FIGURE 5-2 Irrigation, Stillaguamish Basin

## WATER RESOURCES

### Water Supply

The irrigated lands are served by diversions from the Stillaguamish River and its tributaries and from ground water. About 70 percent of the lands are served from surface sources and 30 percent from ground water.

Although records of runoff of the Stillaguamish River near the mouth are not available, the runoff is estimated to average over 2 million acre-feet annually. The recorded runoff of the North and South Forks is shown in Table 5-1. The annual runoff of the North Fork of the Stillaguamish River averages 1,339,000 acre-feet. The South Fork runoff averages about 786,000 acre-feet annually. The Stillaguamish River is characterized by a high runoff period in early winter with another peak occurring in April and May. About 45 percent of the annual runoff occurs during the April-October season. Minimum flows occur in August and September.

The quality of surface waters for irrigation is excellent. This is evidenced by analyses of samples taken and by the fact that irrigation has been practiced in the Basin for many years with no apparent harmful effects to soils or crops. Sediment transport is small except during periods of high runoff and does not pose a serious problem for irrigation.

An adequate supply of ground water is found in the silts, sands and gravels located in the western lowland areas. Moderate to high ground water yields are found near the confluence of the North and South Forks of the Stillaguamish River. Large yields are obtained from wells tapping clean gravel. An example is the city well at Arlington which has a capacity of 1,000 gallons per minute. Small to moderate yields are obtainable in the alluvial plain west of the confluence and along the North and South Forks. Areas deficient in ground water are located north of the mouth of the Stillaguamish River near the communities of Cedarhome and East Stanwood.

From all indications ground water is of suitable quality for irrigation purposes. Most ground waters are low in dissolved solids. Iron is the most objectionable constituent of the ground water supply. Much of the alluvium and glacial outwash and some of the glacial till carry water containing excessive amounts of iron.

### Water Rights

There has been no adjudication for the use of water in the drainages of this Basin. Irrigation rights comprise about 35 percent of the combined surface and ground water rights.

As of April 30, 1967, there were 3,900 acres of land in the Basin that had a permit or a certificate for a surface water right. The maximum diversion to serve this acreage, together with combined rights for stock and domestic water, is approximately 35 cubic feet per second.

Ground water irrigation rights as of September 30, 1966, totaled about 18 cubic feet per second for 1,400 acres.

### Water Requirements

The irrigation requirements for the Stillaguamish Basin were estimated using precipitation data from the Arlington station and temperature data from Everett. The average precipitation at Arlington during June, July, and August is 5.5 inches. July precipitation averages less than one inch.

**TABLE 5-1. Monthly and annual runoff—1,000's of acre-feet (period 1931-1960)**

| | Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOUTH FORK STILLAGUAMISH RIVER near GRANITE FALLS: (119 sq. mi.) | | | | | | | | | | | | | | |
| Max. | (1950) | 83.6 | 125.8 | 117.9 | 79.4 | 103.0 | 120.5 | 91.0 | 96.4 | 119.4 | 63.2 | 39.7 | 21.0 | 1,060.9 |
| Min. | (1941) | 68.6 | 62.6 | 78.2 | 59.6 | 32.2 | 31.6 | 27.0 | 60.8 | 25.4 | 9.0 | 6.0 | 53.7 | 514.7 |
| Mean | | 65.8 | 89.7 | 101.5 | 85.7 | 65.0 | 64.8 | 76.6 | 86.0 | 69.4 | 36.0 | 17.0 | 28.1 | 785.6 |
| NORTH FORK STILLAGUAMISH RIVER near ARLINGTON: (262 sq. mi.) | | | | | | | | | | | | | | |
| Max. | (1959) | 118.9 | 266.6 | 249.4 | 265.2 | 98.3 | 150.0 | 240.4 | 157.3 | 122.5 | 51.9 | 28.8 | 143.9 | 1,893.2 |
| Min. | (1941) | 101.5 | 102.3 | 145.6 | 113.9 | 66.1 | 60.5 | 48.3 | 90.6 | 42.0 | 20.7 | 13.8 | 80.0 | 885.3 |
| Mean | | 98.9 | 151.7 | 183.9 | 160.0 | 124.9 | 124.3 | 134.9 | 136.3 | 103.2 | 52.9 | 27.7 | 40.6 | 1,339.3 |

PHOTO 5-2. Typical view of farmlands west of Arlington. Agricultural terrain is nearly level to slightly rolling. (USBR photo)

The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

Annual consumptive use of the irrigated crops is estimated at 2.18 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 1.00 acre-feet per acre in a dry year. The consumptive use then to be met by irrigation would be about 1.18 acre-feet per acre. With an estimated farm irrigation efficiency of 65 percent, a farm delivery requirement of 1.82 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of five percent of the diverted amount, the presently irrigated lands (2,200 acres) require an average annual diversion of about 4,200 acre-feet. The monthly irrigation requirements are shown in Table 5-2.

Net return flow from the irrigated lands would be about 1,300 acre-feet annually. The resulting depletion of ground and surface water would be 2,900 acre-feet annually.

TABLE 5-2. Irrigation requirements

| | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|
| Distribution | 18% | 37% | 30% | 15% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .22 | .43 | .35 | .18 | 1.18 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .34 | .66 | .55 | .27 | 1.82 |
| Diversion Requirement (Acre-Feet/Acre) | .35 | .71 | .58 | .28 | 1.92 |

## Adequacy of Supply

With few exceptions the quantity of the waters in the Basin are adequate to meet the present irrigation needs of the area. Some areas, such as those near the mouth of the Stillaguamish River, are deficient in ground water. Also, irrigators located along small tributaries may experience problems during periods of low flows.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation to the Basin is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $10,000 from increased crop production and $148,000 from increased production of livestock and livestock products for a total annual value of $158,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964 and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect Basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 905 farms in the Stillaguamish Basin. Only 20 of the farms, about 2 percent, had irrigated cropland in 1964. As shown in Table 5-3, dairy and other livestock farms are the most common farming enterprise in the Basin identified by source of farm income.

**TABLE 5-3. Farm types—1964 [1]**

| Type of Farm | Estimated Number in Basin[2] | Percent of Total |
|---|---|---|
| Field Crops | 0 | 0 |
| Vegetable | 10 | 1.1 |
| Fruit and Nut | 25 | 2.8 |
| Poultry | 25 | 2.8 |
| Dairy | 145 | 16.0 |
| Other Livestock | 75 | 8.2 |
| General | 10 | 1.1 |
| Miscellaneous | 615 | 68.0 |
| Total | 905 | 100.0 |

[1] Estimated from Census of Agriculture.

[2] Rounded to the nearest 5.

The average size of commercial farms is about 80 acres, and farms with irrigated cropland average about 120 acres. Commercial farms with dairy cows average 35 cows per farm.

Livestock enterprises make up slightly more than 80 percent of all farm operations. Over 95 percent of the irrigated cropland is in forage crops. Dairy and other livestock farms are the most numerous farm types with irrigated cropland.

### Crops

Total crop production related to irrigation use is shown in Table 5-4.

Irrigated forage crops are hay and pasture and these are generally a grass or grass-clover mix. The early crop of grass, generally cut in May, is harvested for silage or green feed, because the weather is too wet to make hay or to graze. Later in the season most of this same cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basin.

Sweet corn is the only commercial vegetable crop irrigated in the Basin. Most of it is marketed to local processors for canning and freezing.

**TABLE 5-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre[1] | Total[2] |
|---|---|---|---|---|
| Forages | 2,140 | | | |
| Hay | (860) | Ton | 1.32 | 1,140 |
| Pasture | (1,280) | AUM | 3.14 | 4,020 |
| Vegetables | | | | |
| Sweet Corn | 30 | Ton | 1.33 | 40 |
| Berries | 30 | Ton | 1.00 | 30 |
| Strawberries | (20) | Ton | (1.06) | (20) |
| Raspberries | (10) | Ton | (.84) | (10) |
| Total | 2,200 | | | |

[1] See The Puget Sound Area for method of derivation.

[2] Rounded to the nearest 10.

Irrigated strawberries and raspberries are grown commercially in the Basin, and marketed primarily to local processors for freezing.

## Crop Values

Crop values related to irrigation are shown in Table 5-5.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basin. Meat packing plants are located within the Basin and at nearby towns. Fluid milk is shipped to Mt. Vernon and Everett for processing. The largest livestock sales yard in the Puget Sound Area is located at Marysville, about 10 miles from the Basin. The derivation of estimated animal units of feed requirements and production is shown in Table 5-6.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises, provides about 3.6 percent of the total feed required in the Basin. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation, based on total digestible nutrients (T.D.N.) requirements, is shown in Table 5-7. The production is based on 3.6 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 5-6.

In terms of T.D.N.'s only, the full feed requirements of about 990 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basin raise all of their feed. In reality, the nutritional requirements of many more than 990 head of cattle are partially satisfied by irrigated feeds.

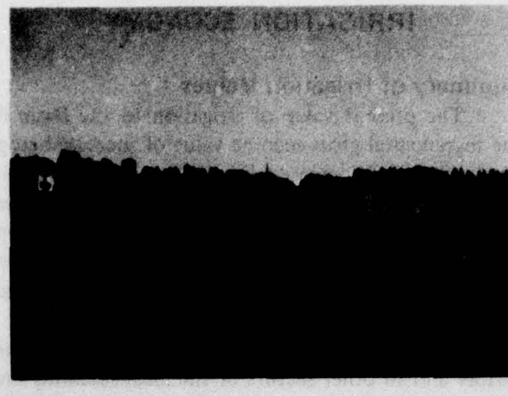


PHOTO 5-3. Irrigating forage near Arlington.(USBR photo)

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 5-8. The value estimates are based on the proportion of feed attributable to irrigation.

**TABLE 5-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value: Per Unit[1] (Dollars) | Value: Total (Dollars) |
|---|---|---|---|---|
| Forage | | | | |
| Hay | Ton | 1,140 | | 2 |
| Pasture | AUM | 4,020 | | 2 |
| Vegetables | Ton | 40 | 26 | 1,000[3] |
| Berries | Ton | 30 | 290 | 8,700 |
| Total | | | | 9,700 |
| Rounded | | | | 10,000 |

1 Weighted average prices received—adjusted normalized basis:
Sweet Corn—$26/Ton; Strawberries—$270/Ton; Raspberries—$330/Ton

2 Value accounted for in livestock and livestock product values.

3 Rounded to the nearest $100.

TABLE 5-6. Estimated feed requirements and production

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 7,340 | 12,258 |
| Per Feeder | .58 | 1,310 | 760 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 2,210 | 2,807 |
| Per Feeder | .38 | 1,720 | 654 |
| Total | | | 16,479 |
| Rounded | | | 16,500 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grains | | | |
| Hay–Ton | 1,140 | .20 | 228 |
| Pasture–AUM | 4,020 | .08 | 322 |
| Small Grains–Ton | | | |
| Corn Silage–Ton | | | |
| Total | | | 550 |
| Rounded | | | 600 |

1 Rounded to the nearest 10 head.

2 Includes feed required for bulls and young stock usually associated with the breeding herd.

3 Animal Units of feed per ton/AUM.

TABLE 5-7. Estimated production of livestock and livestock products related to irrigation

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 8,606 head | 18,820 head | 27,426 head | 3.6 | 990 head |
| Milk | 68,794,470 lbs. | | 68,794,470 lbs. | 3.6 | 2,476,600 lbs. |
| Butterfat in cream | 25,030 lbs. | | 25,030 lbs. | 3.6 | 900 lbs. |

1 Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 5-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (Dollars) | Adjustment Factor[1] | Adjusted Value of Sales (Dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (Dollars) |
|---|---|---|---|---|---|
| Dairy Products | 3,243,600 | 1.051 | 3,409,024 | 3.6 | 122,700 |
| Cattle and Calves | 680,000 | 1.051 | 714,680 | 3.6 | 25,700 |
| Total | | | | | 148,400 |
| Rounded | | | | | 148,000 |

[1] Prices received—Livestock and Livestock products:

$$\frac{\text{Long-term adjusted normalized index}}{\text{1984 Index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Stillaguamish Basin total 12,020 acres, of which 2,530 are presently irrigated and 9,490 are potentially irrigable. The lands are located on recent alluvial bottoms along the Stillaguamish River, and high-lying hill lands bordering the bottom land area. About 10,500 acres are expected to be under irrigation in the Basin by the year 2020.

### Land Characteristics

Soils within this basin have developed under the influence of humid climate and moderate temperature. Surface soil textures are generally medium to fine, of medium grade structure, and friable. Subsoils generally have medium grade, subangular, blocky structure which ranges from friable to firm. The occurrence of water stable aggregates or granules in the soil allows free movement of water through the soil while maintaining a desirable moisture holding capacity. Natural fertility is moderate to high, but addition of fertilizers gives favorable economic returns.

Recent alluvial bottom lands are suited to the production of all crops adapted for the climate of the area, which includes grass and legumes for pasture, strawberries, raspberries, and vegetable crops. Local size and drainage conditions may limit production to specialized crops in places. The higher-lying hilly glacial lands, if cleared of the present tree cover, would be best suited to production of pasture crops. However, some of the general farm crops could also be grown on these lands.

The delta plain is smooth. Slopes of potentially irrigable lands are mostly undulating to nearly level. Many stream channels have cut through the arable land in the valley, but usually large acreages of good land lie between these channels. There are very few slopes over 5 percent in the arable lands. During the classification, about 400 acres of land were graded down because of topography deficiencies. These lands are in small, irregular shaped fields, separated from other land areas by stream channels, roads, railroads and drainage ditches.

### Land Classes

Potentially irrigable lands in the Basin total 9,490 acres, of which 40 acres are in woodlands.

The following tabulation shows the acreage distribution of the potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (Acres) | Potentially Irrigable in Tree Cover (Acres) | Total (Acres) |
|---|---|---|---|
| 1 | 1,320 | | 1,320 |
| 2 | 2,140 | 10 | 2,150 |
| 3 | 5,990 | 30 | 6,020 |
| Total | 9,450 | 40 | 9,490 |

These lands are shown on Figure 5-2.

## PROJECTION OF FUTURE IRRIGATION

Projections are that about 8,000 acres of new lands will eventually be under irrigation in the Basin.

Present and future irrigation water demands are:

| Year | New Irrigation (acres) | Supply Source GW (acres) | Supply Source SW (acres) | Surface Diversions Annual (ac. ft.) | Surface Diversions Peak (cfs) |
|---|---|---|---|---|---|
| Present | -- | 700 | 1,800 | 3,500 | 23 |
| 1980 | 4,000 | 2,000 | 2,000 | 4,000 | 25 |
| 2000 | 4,000 | 2,000 | 2,000 | 4,000 | 25 |
| 2020 | -- | -- | -- | -- | -- |

Maximum irrigation requirements for the area are:

| | | |
|---|---|---|
| Peak farm delivery requirement | 79 | acres/cfs |
| Farm delivery requirement | 1.82 | acre-feet/acre |
| Diversion requirement | 1.92 | acre-feet/acre |

The monthly distribution of the irrigation requirement is shown as percent of the annual demand.

| | |
|---|---|
| June | 18% |
| July | 37% |
| August | 30% |
| September | 15% |
| Total | 100% |

# MEANS TO SATISFY NEEDS

Future irrigation development in the Stillaguamish Basin is expected to be by private means. Snohomish County is studying the possibility of zoning the area west of Arlington to the mouth of the Stillaguamish River as all agricultural.

The most likely source of surface supply for irrigation development is the Stillaguamish River. Streamflow records indicate that there is adequate water in the river to meet the future irrigation needs. However, when other needs of the Basin are con-

**PHOTO 5-4. Potentially irrigable lands near the vicinity of Arlington. (USBR photo)**

sidered, storage may be required. Most of the potentially irrigable lands are located near the Stillaguamish River or in areas with good ground water supplies. The projected investment costs for the Stillaguamish Basin are shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $540,000 | -- |
| 1980-2000 | $540,000 | -- |
| 2000-2020 | -- | -- |

For the 1980 level of development the annual operating costs are estimated to be $36,000. The operating costs include power, operation, maintenance and replacement costs. If upstream storage is required to meet the water supply needs, additional costs would be involved. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new potentially-irrigable lands would amount to approximately $72 per acre and is summarized as follows:

| Year | New Irrigation (Acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | 4,000 | $288,000 |
| 2000 | 4,000 | $288,000 |
| 2020 | | |

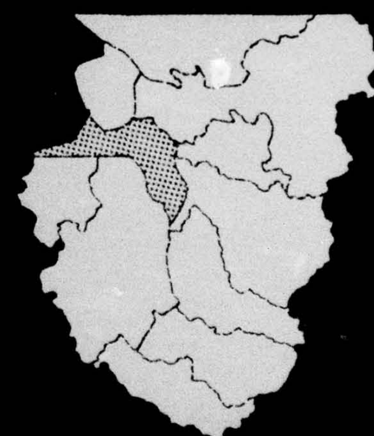
The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system, are discussed in The Puget Sound Area under Means to Satisfy Needs.

Estimated net depletions of surface and ground water sources in the Basin to meet irrigation needs are shown below:

| Year | New Irrigation (acres) | Net Depletion[1] GW (ac.ft.) | Net Depletion[1] SW (ac.ft.) | Total Accumulated Depletion (ac.ft.) |
|---|---|---|---|---|
| Present | | 900 | 2,400 | 3,300 |
| 1980 | 4,000 | 2,700 | 2,700 | 8,700 |
| 2000 | 4,000 | 2,700 | 2,700 | 14,100 |
| 2020 | | | | 14,100 |

[1] Diversion requirements minus return flow.

# Whidbey-Camano Islands



# WHIDBEY-CAMANO ISLANDS

Whidbey-Camano Islands are in northwestern Washington in the northern end of Puget Sound. Whidbey Island covers about 170 square miles. It is separated from the mainland by a deep salt water gorge which ranges in depth up to 1,300 feet at the northerly end where it narrows at Deception Pass. A high-level arch bridge over Deception Pass provides vehicular access to the Island. Camano Island lies between Whidbey Island and the mainland and covers about 40 square miles. It is separated from the mainland by a narrow slough, which is bridged near Stanwood.

Lands of both islands originated largely from glacial drift consisting of sand, gravel, and some clay. In the glaciated areas, relief is relatively regular and uniform ranging in elevation from 100 to 300 feet with a few features exceeding 500 feet. There are no large streams on the Islands and most of the small streams flow intermittently. A few streams in the southern part of Whidbey Island are fed by springs that flow throughout the year. There are also several small fresh-water lakes throughout the area.

The Islands have one of the most uniform marine climates of any area in the United States. The Cascade Range to the east shelters the Islands from cold continental winds, and temperatures are modified by prevailing westerly winds—rarely going over 90°F or below 0°F. The average annual precipitation and temperature at Coupeville on Whidbey Island are about 18 inches and 50°F.

Most of the area was originally covered by dense forests. All of the virgin timber has been cut and in many places second and third cuttings have been made.

Land use is predominantly in forest. The following tabulation shows the estimated land use on the Islands.

| | Acres |
|---|---|
| Cropland | 23,000 |
| Rangeland | 2,000 |
| Forest | 85,000 |
| Rural nonagricultural | 12,000 |
| Built-up areas | 11,000 |
| Total | 133,000 |

PHOTO 6-1. General view of northern end of Whidbey Island looking south. Deception Pass Bridge in foreground and Oak Harbor in the distance. (USBR photo)

PHOTO 6-2. Farmlands on Whidbey Island west of Oak Harbor. View is looking south towards Coupeville at center of photo. Camano Island on upper left (USBR photo)

Lumbering, agriculture, recreation, and military installations form the base of the local economy. No industrial enterprises of any size are on the Islands and most of the timber is used locally as are the agricultural products.

Agriculture is located largely on the northern half of both islands. Shifts in land use have been extreme. The number of farms has decreased and lands formerly cropped have been taken over by other uses. The prairies have been cropped or pastured since the area was first settled. Potatoes, hay, wheat, and oats were the leading crops for many years. Except for potatoes, these crops are still important, with vegetables and other specialized crops replacing potatoes.

Recreational attractions are numerous and varied. The long coast lines, and the sheltered bays and beaches provide many opportunities for outdoor recreation.

The population of the Islands in 1964 was about 22,500. On Whidbey Island, the population increased about 82 percent from 1940 to 1950 with the establishment of military bases at Oak Harbor and Crescent Harbor. Oak Harbor with a population of 4,850 in 1960 is the only incorporated town in the area. Other principal towns are Coupeville, Langley, and Clinton on Whidbey Island, and Camano, and Utsaladdy on Camano Island.

## PRESENT STATUS

Irrigation development is small but has been steadily increasing during the past 25 years.

About one half of the irrigated lands lie in the north-central portion of Whidbey Island. This part of the Island is influenced by the shielding effect of the Olympic Mountains, and the climate is of a semi-arid character similar to the Sequim area. At the southern end of the Island and on Camano Island, the climate tends to be more typical of other Basins in the Puget Sound Area.

In 1965, about 2,700 acres were irrigated on the Islands. However, the acreage normally irrigated is

**PHOTO 6-3. Irrigated pasture north of Oak Harbor. (USBR photo)**

estimated to be about 900 acres. The relationship between crop consumptive use, effective precipitation, and crop irrigation requirement is shown on Figure 6-1.

## IRRIGATED LANDS

The irrigated lands are in scattered locations on both Whidbey and Camano Islands. Irrigation development has been limited due to marginal soils and lack of adequate water supplies. The irrigated lands occupy the areas where a water supply is easily obtainable.

Soils have developed from glacial drift parent material and vary considerably in texture, permeability, and consistency. Most of the soils are underlain by sand, gravel, and cobble.

Response of crops to irrigation is most noticeable on the coarser textured soils that dry out early in the spring. However, crops produced on the heavier textured soils respond well when irrigated.

Topography is fairly regular and uniform ranging from nearly level to undulating. Most of the slopes are long and fairly smooth, but there are a few sprinkler irrigated pastures on rough, rolling topography. Very little irrigation is practiced on flat level land. Nearly half of present irrigation is on lands with a 5 percent or greater slope.

Irrigated lands on Whidbey-Camano Islands were classified as classes 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 6-2. A summary of the lands irrigated in 1965, is shown below.

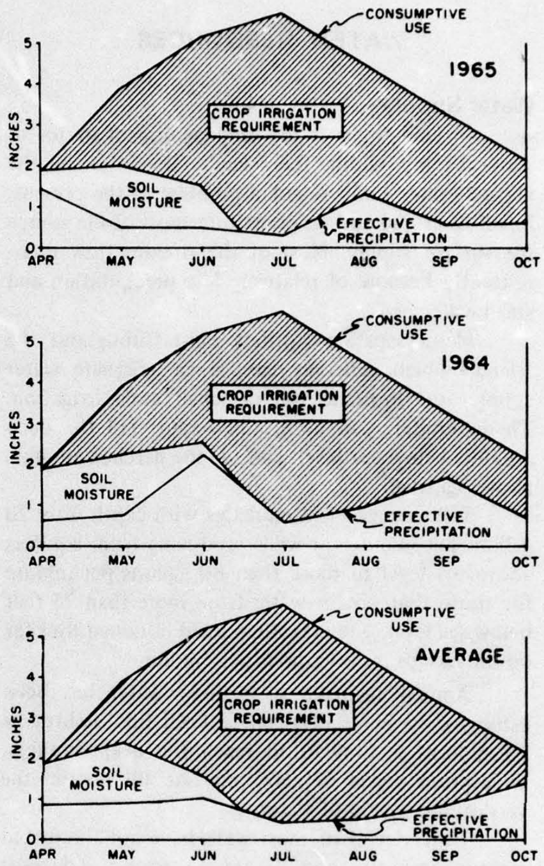



**FIGURE 6-1. Crop irrigation requirements for typical dry, wet, and average years.**

| Land Class | Irrigated (Acres) |
|---|---|
| 1 | 0 |
| 2 | 500 |
| 3 | 2,160 |
| Total | 2,660 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Ground water is the only significant source of water supply within the Islands. Depletion of the ground water body is not a problem at the present. Small lakes and springs constitute most of the source for surface supply. Most of the streams flow intermittently because of relatively low precipitation and small watersheds.

Many separate aquifers exist throughout the Islands which generally furnish an adequate water supply for domestic use or small scale irrigation. These aquifers can be grouped into: (1) the deep aquifers below sea level, and (2) the perched aquifers above sea level.

The average yield increases with depth from 20 gallons per minute for wells producing from aquifers above sea level to more than 80 gallons per minute for those that obtain water from more than 75 feet below sea level. The maximum yield obtained thus far on the Islands is 600 gallons per minute.

Annual recharge to ground water has been estimated to be 10,000 acre-feet. Of this, as little as 25 percent is thought to reach the deep aquifers. Widespread layers of clay and fine till restrict the vertical movement of water.

Water levels of most wells have not fluctuated greatly over the past 10 to 15 years; and most fluctuations have been less than two feet.

Water quality is at a level suitable for irrigation of the crops grown. Ground water has been used for 20 years and has caused no serious effects on soils or crops. The major quality problems experienced now are primarily from salt water contamination or saline water from older formations. The saline-affected wells are few and located throughout the Islands.

### Water Rights

A large portion of the total water rights are for irrigation purposes. Irrigation surface water rights on the two Islands have a total maximum appropriation of about 7 cubic feet per second for 730 acres. Irrigation ground water rights total about 9 cubic feet per second for 810 acres. There has been no adjudication of water rights for Whidbey-Camano Islands.

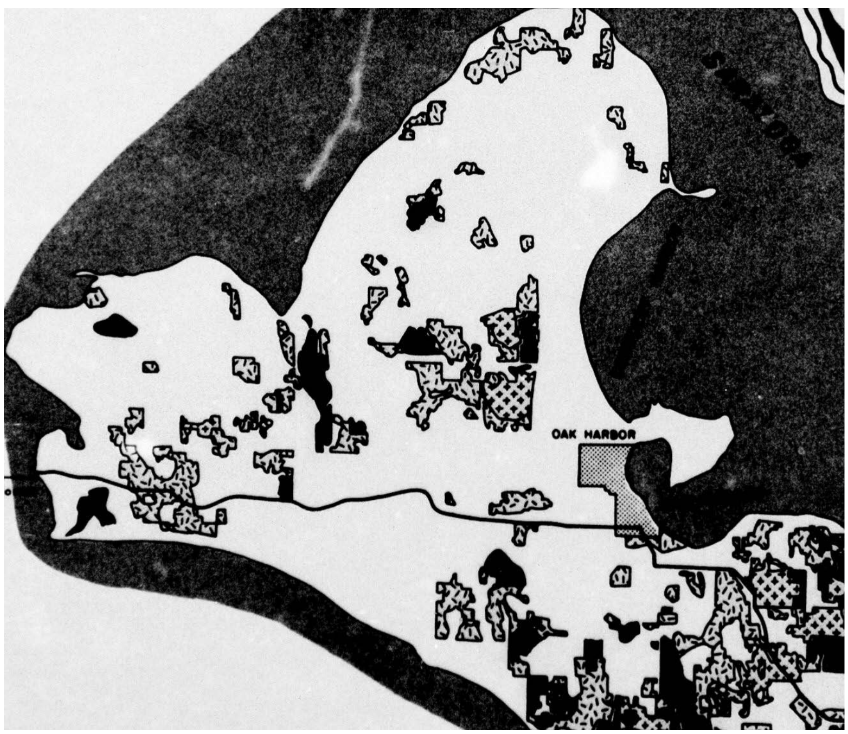
### Water Requirements

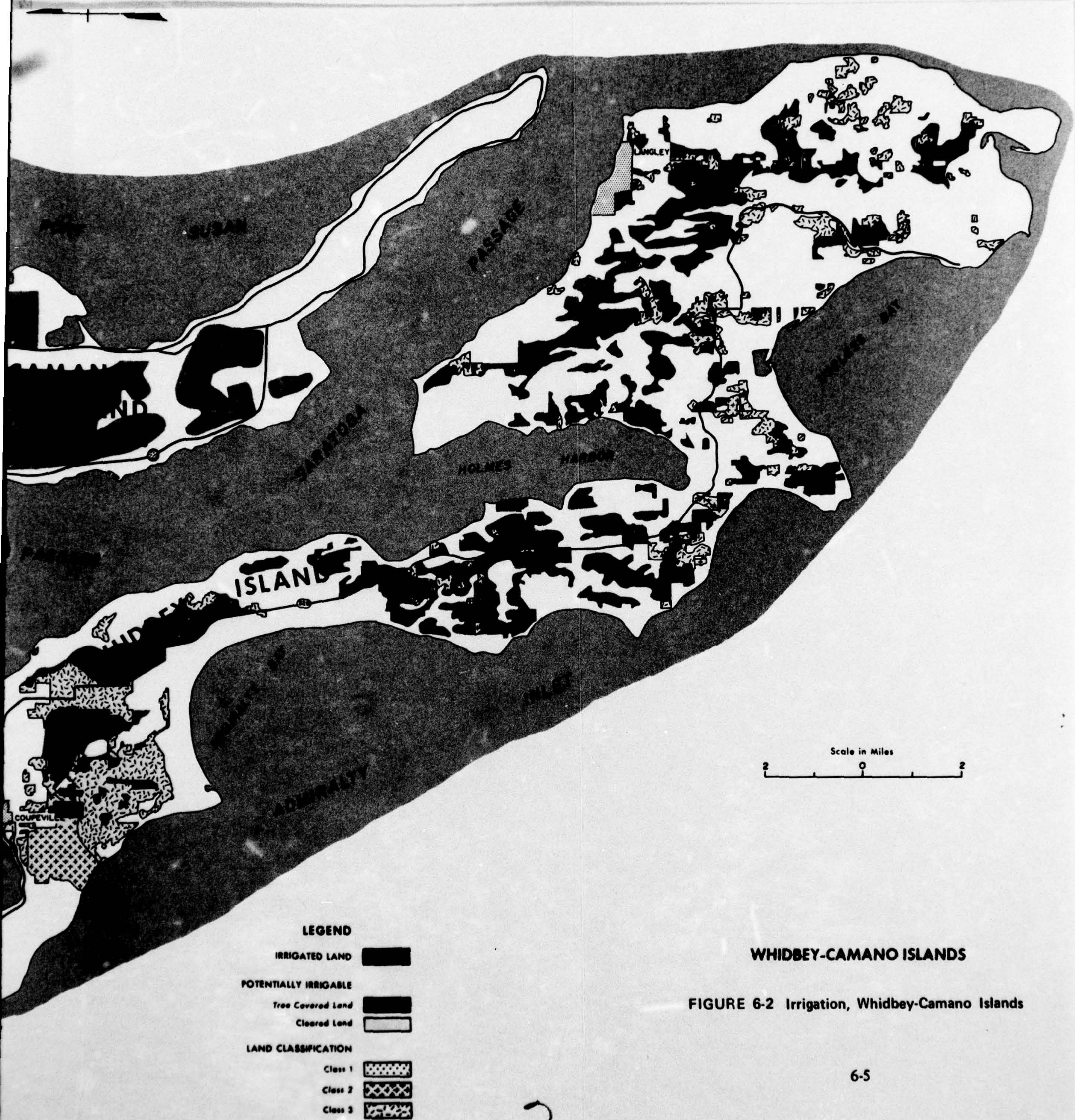
Because of the similarity between the central portion of Whidbey Island and the Sequim area, irrigation requirements were estimated using climatological data from the Sequim station. The average precipitation at Sequim for the months of June, July and August totals about two inches. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

Annual consumptive use of the irrigated crops is estimated to be about 2.21 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.65 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.56 acre-feet per acre. With an estimated farm irrigation efficiency of 60 percent, a farm delivery requirement of 2.60 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of five percent of the diverted amount, the presently irrigated lands (900 acres) would require an average annual diversion of 2,500 acre-feet. Most of this would come from ground water. The monthly irrigation requirements are presented in Table 6-1.

**TABLE 6-1. Irrigation requirements**

| Item | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|
| Distribution | 6% | 23% | 29% | 21% | 15% | 6% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .09 | .36 | .45 | .33 | .24 | .09 | 1.56 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .15 | .62 | .75 | .55 | .38 | .15 | 2.60 |
| Diversion Requirement (Acre-Feet/Acre) | .16 | .63 | .80 | .58 | .41 | .16 | 2.74 |


OAK HARBOR




WHIDBEY-CAMANO ISLANDS

FIGURE 6-2 Irrigation, Whidbey-Camano Islands



2

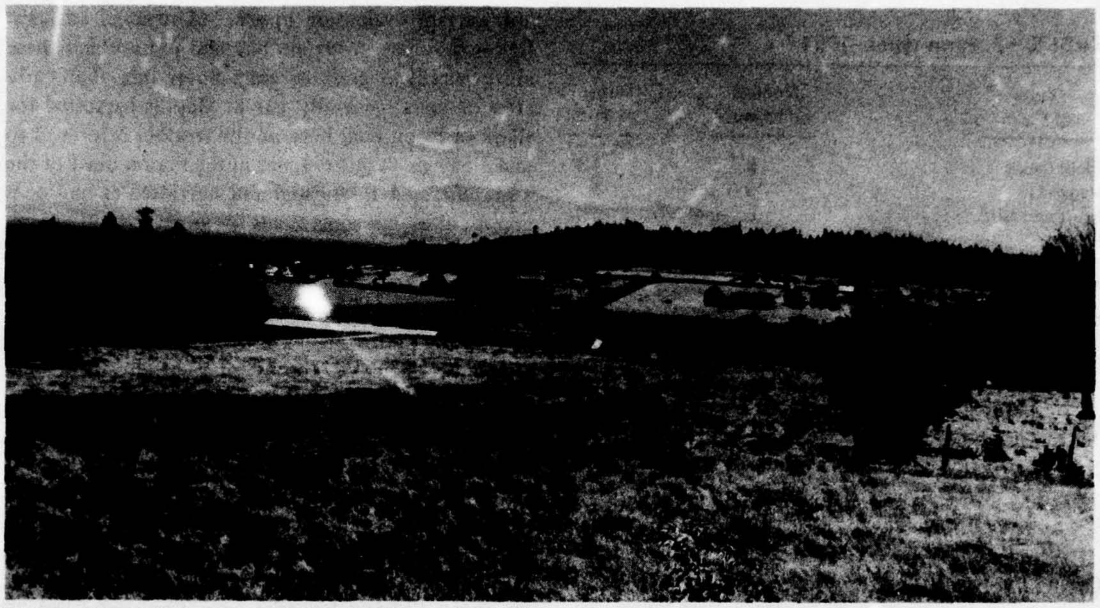


**PHOTO 6-4. Typical view of farmlands showing gently rolling topography characteristic of the Islands. Whidbey Island near Mutiny Bay. (USBR photo)**

Some recharge of ground water from irrigation return flow occurs, but is not significant. The recharge of the high yielding aquifers is slow due to the low permeability of the glacial till.

### Adequacy of Supply

Relatively minor long-term fluctuations of water levels suggest that ground water in storage is not being depleted. The quantity of ground water on Whidbey-Camano Islands is adequate for present irrigation demands. However, the yield or rate at which the water can be withdrawn from the aquifers is very low in most cases. This places definite restrictions on the number of acres which can actually be irrigated from any one well.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased livestock production attributable to irrigation in an average year. This incremental value is $46,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in The Puget Sound Area section of this appendix.

### Basic Data

Agricultural Census data for 1964, and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. Adjustments to census data are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 440 farms on Whidbey-Camano Islands. About 20 farms, 4.5 percent of the total, had irrigated cropland in 1964. As shown in Table 6-2, dairy and other livestock farms are the most common farming enterprises on the Islands identified by source of farm income.

The average size of commercial farms is about 130 acres and farms with irrigated cropland average about 100 acres. Commercial farms with milk cows average 18 cows per farm.

Essentially all of the irrigated cropland is in forage crops. Dairy and other livestock farms constitute all of the farm types with irrigated cropland.

TABLE 6-2. Farm types—1964[1]

| Type of Farm | Number on Islands[2] | Percent of Total |
|---|---|---|
| Field Crops | 5 | 1.1 |
| Vegetable | 0 | 0 |
| Fruit and Nut | 5 | 1.1 |
| Poultry | 25 | 5.7 |
| Dairy | 35 | 8.0 |
| Other Livestock | 45 | 10.2 |
| General | 15 | 3.4 |
| Miscellaneous | 310 | 70.5 |
| Total | 440 | 100.0 |

1 Estimated from Census of Agriculture.

2 Rounded to the nearest 5.

## Crops

Total crop production related to irrigation is shown in Table 6-3.

TABLE 6-3. Estimated land use and crop production related to irrigation

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation | |
|---|---|---|---|---|
| | | | Per Acre | Total[1] |
| Forages | | | | |
| Hay | 480 | Ton | 1.90 | 910 |
| Pasture | 420 | AUM | 4.52 | 1,900 |
| Total | 900 | | | |

1 Rounded to the nearest 10.

Limited surface water, expensive ground water sources and generally poor quality croplands have severely limited the development of irrigated crops other than forages. Better quality croplands suitable for row crops generally have limited or expensive water sources. These lands are used for crops which are not irrigated, such as green peas.

All of the irrigated cropland has been evaluated in terms of increased production of forage crops. Irrigated acreages of other crops are so minor they do not warrant evaluation in a broad regional analysis. Irrigated forage crops are hay and pasture and these are generally a grass or grass-clover mix. The early crop of grass, generally cut in May, is harvested for silage or green feed because the weather is too wet to make hay or to graze. Later in the season most of the same cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used on the Islands.

## Crop Values

Crop values related to irrigation are evaluated in terms of increased production of livestock and livestock products.

## Livestock

Cattle operations are the major livestock enterprises on the Islands. There are no processing plants for livestock products on either Whidbey or Camano Island. However, meat packers and dairy processors are located about 40 miles from Coupeville and 30 miles from the town of Camano. The major livestock sales yard in the Puget Sound Area is located about 40 miles from both towns. The derivation of estimated animal units of feed requirements and production is shown in Table 6-4.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 4.8 percent of the total feed required in the Islands. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

PHOTO 6-5. Irrigating pasture on Camano Island. (USBR photo)

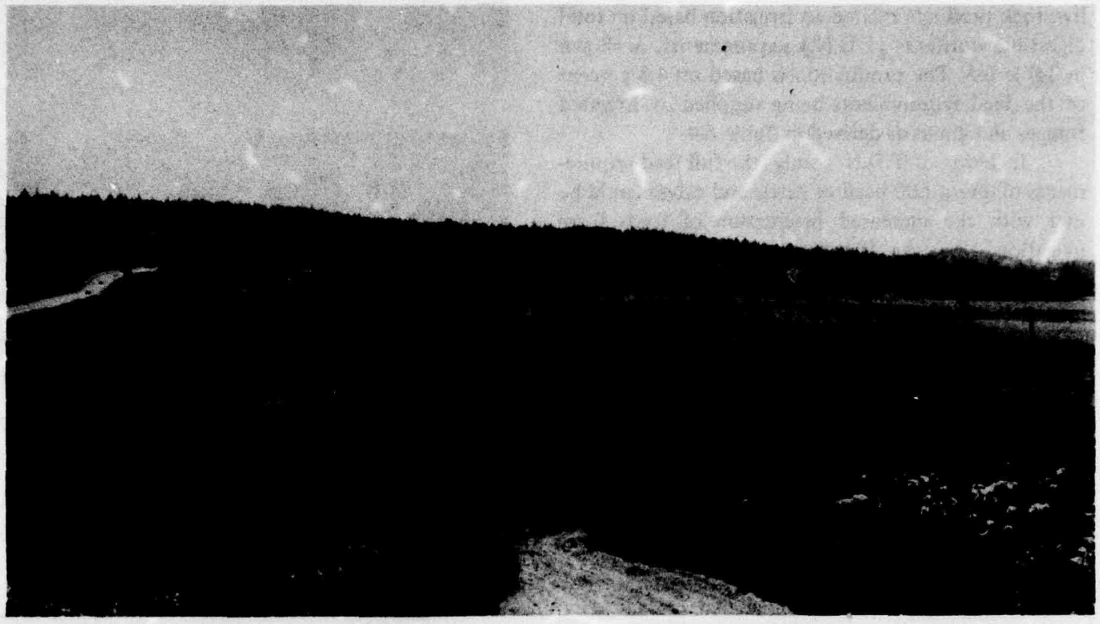


PHOTO 6-6. Black Angus grazing in pasture north of Oak Harbor. (USBR photo)

**TABLE 6-4. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 1,500 | 2,505 |
| Per Feeder | .58 | 1,130 | 655 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 2,130 | 2,705 |
| Per Feeder | .38 | 890 | 338 |
| Total | | | 6,203 |
| Rounded | | | 6,200 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grain | | | |
| Hay–Ton | 910 | .20 | 182 |
| Pasture–AUM | 1,900 | .08 | 152 |
| *Small Grains–Ton* | | | |
| Corn Silage–Ton | | | |
| Total | | | 334 |
| Rounded | | | 300 |

1 Rounded to the nearest 10 head.

2 Includes the normal number of replacement stock and bulls on a per head basis.

3 Animal Units of feed per ton/AUM.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrients (T.D.N.) requirements, is shown in Table 6-5. The production is based on 4.8 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 6-4.

In terms of T.D.N.'s only, the full feed requirements of about 600 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Islands raise all of their feed. In reality, the nutritional requirements of many more than 600 head of cattle are partially satisfied by irrigated feeds.

**PHOTO 6-7. Portable feeders on dairy farm—Camano Island. (USBR photo).**

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 6-6. The value estimates are based on the proportion of feeds attributable to irrigation.

**TABLE 6-5. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total[1] | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 3,601 head | 8,810 head | 12,410 head | 4.8 | 600 head |
| Milk | 12,374,000 lbs. | | 12,374,000 lbs. | 4.8 | 594,000 lbs. |
| Butterfat in cream | 900 lbs. | | 900 lbs. | 4.8 | 0 lbs.[2] |

1 Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

2 Rounds to less than 100 lbs.

**TABLE 6-6. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (Dollars) | Adjustment Factor[1] | Adjusted Value of Sales (Dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (Dollars) |
|---|---|---|---|---|---|
| Dairy Products | 526,900 | 1.051 | 553,772 | 4.8 | 26,600 |
| Cattle and Calves | 378,100 | 1.051 | 397,383 | 4.8 | 19,100 |
| Total | | | | | 45,700 |
| Rounded | | | | | 46,000 |

1 Prices received—Livestock and Livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1964 Index}} = \frac{247}{235} = 1.051$$

2 Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands on Whidbey-Camano Islands total 47,740 acres, of which 2,660 are presently irrigated and 45,080 are potentially irrigable. About 33,000 acres of the potentially irrigable lands are on Whidbey and 12,000 on Camano.

### Land Characteristics

Soils of the potentially irrigable lands have developed from glacial drift which was deposited in moraines left by glaciers that once moved over the Puget Sound Area. Soils underlain by a cemented gravelly till comprise about one-half the potentially irrigable lands. Natural fertility of these lands is low. They would be best suited to production of pasture and hay crops.

Soils with open, porous profiles make up about 30 percent of the potentially irrigable lands. These soils, which can usually be expected to show the most response to irrigation because of their slight to severe droughtiness, are represented by the glacial upland soils and the fertile productive terrace soils. These soils would be well suited to production of all crops adapted to the Islands.

About 20 percent of the potentially irrigable lands have fine textured slowly permeable subsoils. These soils occupy terrace positions and are generally in the Coupeville series. They are fertile and very productive. Organic soils occupy only a small part of the potentially irrigable lands.

About 75 percent of the potentially irrigable land is undulating to gently rolling with slopes between 5 and 12 percent. Only on the Ebeys Prairie and Smith Prairie areas, south of Coupeville, are there large areas of nearly level land with smooth slopes of 2 to 3 percent. In general, the organic soils and depression soils are nearly level to slightly sloping, terrace soils are slighly sloping and the glacial upland soils are mostly undulating to rolling with slopes over 6 percent.

All potentially irrigable lands are well adapted to sprinkler irrigation.

About 4,000 acres of the potentially irrigable lands have varying degrees of drainage problems. On the glacial upland soils underlain by glacial till the deficiency is primarily internal. Sprinkler application would be the practicable method on these lands. Imperfectly and poorly drained organic soils, and some depression areas would require extensive drainage works to alleviate the condition. Surface drains in some areas would be beneficial in removing excess water of heavy winter precipitation.

### Land Classes

Potentially irrigable lands on Whidbey-Camano Islands total 45,080 acres of which 28,390 acres are presently in woodlands. The following tabulation shows the acreage distribution of potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (Acres) | Potentially Irrigable in Tree Cover (Acres) | Total (Acres) |
|---|---|---|---|
| 1 | | | |
| 2 | 2,800 | 300 | 3,100 |
| 3 | 13,890 | 28,090 | 41,980 |
| Total | 16,690 | 28,390 | 45,080 |

These lands are shown on Figure 6-2.

## PROJECTION OF FUTURE IRRIGATION

With an adequate water supply, about 30,000 acres of new land could be irrigated by 1980.

Present and future irrigation water demands are:

| Year | New Irrigation (Acres) | Supply Source GW (Acres) | Supply Source SW (Acres) | Surface Diversions Annual (ac.ft.) | Surface Diversions Peak (ac.ft.) |
|---|---|---|---|---|---|
| Present | – | 2,000 | 700 | 1,900 | 10 |
| 1980 | 30,000 | 2,000 | 30,700 | 84,000 | 440 |
| 2000 | -- | -- | -- | -- | -- |
| 2020 | -- | -- | -- | -- | -- |

Maximum irrigation requirements for the Islands are:

| | | |
|---|---|---|
| Peak farm delivery requirement | 70 | acres/cfs |
| Farm delivery requirement | 2.60 | acre-feet/acre |
| Diversion requirement | 2.74 | acre-feet/acre |

The monthly distribution of the irrigation requirement is shown as percent of the annual demand.

| | |
|---|---|
| May | 6% |
| June | 23% |
| July | 29% |
| August | 21% |
| September | 15% |
| October | 6% |

# MEANS TO SATISFY NEEDS

Since there is an inadequate ground water supply on the Islands to sustain projected irrigation expansion, alternative methods were investigated for importing a surface water supply.

Cost estimates were prepared for importing irrigation water using the Skagit River as a source to a 10,000 acre area near Oak Harbor. The costs and benefits are shown in the following tabulation:

(Thousands of Dollars)

| Capital Cost | Annual Costs | | | | Annual Benefits | Net Benefits |
|---|---|---|---|---|---|---|
| | Capital | OM&R | Power | Total | | |
| 29,300 | 993 | 120 | 80 | 1193 | 400 | 793 |

As can be noted the irrigation benefits are not sufficient to justify construction of the single-purpose irrigation facilities. However, a multi-purpose water supply development for the Islands may prove feasible. Such alternatives may be:

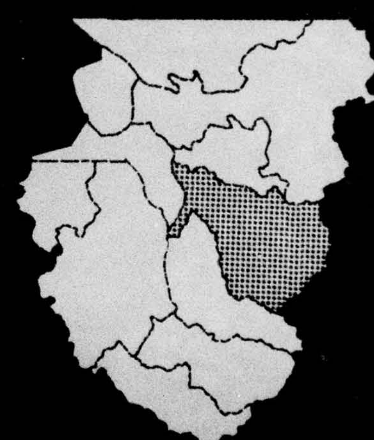
1. Combined irrigation–M&I importation system.
2. Desalinization.
3. Combined nuclear power–desalinization plus M&I and irrigation systems.

Without an economical imported water supply, irrigation is expected to decrease. Some small scattered irrigation development may occur utilizing ground water. This development will be by individual means utilizing on-farm type systems. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new potentially-irrigable lands would amount to approximately $54 per acre.

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

# Snohomish Basin



# SNOHOMISH BASIN

The Snohomish Basin lies in the central portion of the Puget Sound Study Area and contains part of Snohomish and King Counties. The Basin contains approximately 1,863 square miles of land area, with elevations ranging from sea level to over 7,000 feet at Mt. Daniel. The western portion contains rolling glacial soil and terminal moraines entrenched by broad valleys. The eastern portion is heavily forested, mountainous terrain.

Two major river systems unite in the lower part of the Basin to form the Snohomish River. The Skykomish River drains the northeastern part of the Basin while the Snoqualmie River drains the southern part. These rivers originate in the Cascade Range and flow through steep mountainous valleys in their upper reaches. The Snoqualmie River emerges into a mile-wide valley below Fall City. The Skykomish Valley widens at Gold Bar and joins the Snoqualmie Valley below Monroe to form the Snohomish Valley. The Snohomish River enters Puget Sound through Port Gardner and Possession Sound in the vicinity of the city of Everett. Marshes and tidal lowlands are found along the lower section of the Snohomish River which is tidal for about 18 miles.

The Pilchuck River, a fast flowing stream with a narrow flood plain, joins the Snohomish River about 13 miles upstream from the latter's mouth.

The climate of the Snohomish Basin is typical of the Puget Sound Area with relatively cool summers and mild winters. The average annual precipitation ranges from about 35 inches at Everett to over 180 inches in the higher elevations of the Cascade Mountains. Heavy snow packs characteristic of the Cascade Range are found in this Basin, and result in sustained stream flows well into the summer. Mean daily temperatures range, in the winter, from 38°F near the Puget Sound to 23°F at Stevens Pass, and in the summer from 63°F near the Sound to 56°F at Stevens Pass.

Pioneer agricultural communities were established around the town of Snohomish as early as 1861. Agricultural development has continued principally along the rich alluvial valleys of the Basin. Dairy farming is the major agricultural enterprise in the Basin.

Timber and related forest products are produced in the upper mountainous areas. The Sno-

**PHOTO 7-1. Skykomish River Valley. Town of Monroe in foreground looking toward the Cascade Mountains. (USBR photo)**

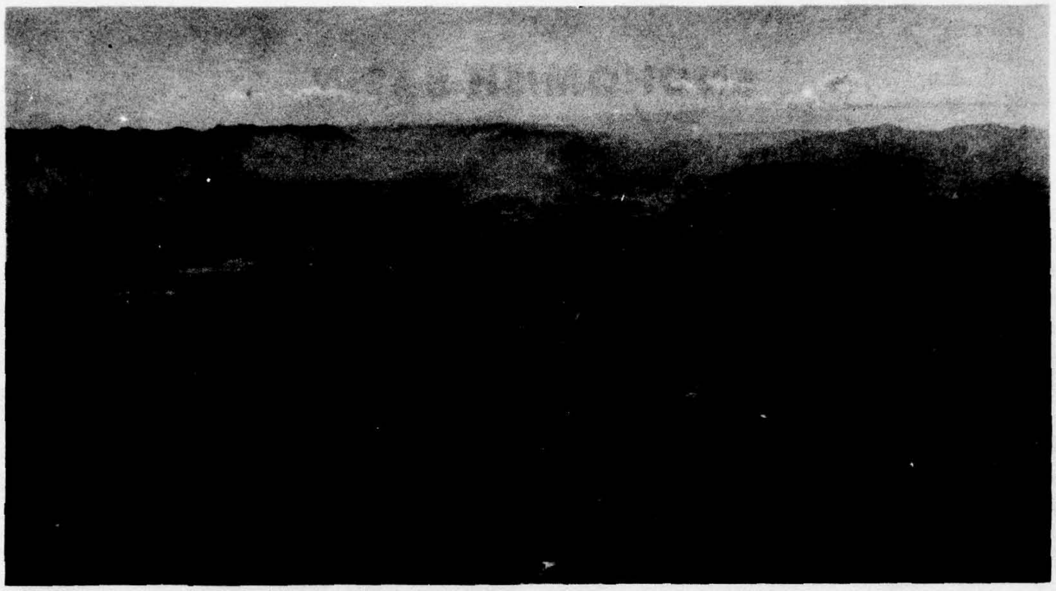


PHOTO 7-2. Snoqualmie River Valley with Mt. Rainier in background. (USBR photo)

qualmie National Forest, State of Washington Department of Natural Resources and private timber companies control most of the forest lands, which are operated on a sustained yield basis. Despite heavy forest cutting there is still a rich resource of timber for sawmills and paper manufacturing.

Everett is the largest city in the Snohomish Basin, ranking fourth in the State with a population of 52,000 (1967). Other cities with populations greater than 1,000 include Snohomish, 4,700; Marysville, 4,000; Monroe, 2,200; Mukilteo, 1,325; Snoqualmie, 1,233; and North Bend, 1,206.

The following tabulation depicts the land use within the Basin:

| | Acres |
|---|---|
| Cropland | 72,000 |
| Rangeland | 2,000 |
| Forest | 1,055,000 |
| Rural nonagricultural | 29,000 |
| Built-up areas | 36,000 |
| Total | 1,194,000 |

# PRESENT STATUS

Development of irrigation in the Snohomish Basin has been extensive along the valley bottomlands. The location and extent of irrigation in a given year depends on summer rainfall and type of crop grown. In 1963, about 12,800 acres were irrigated in the Basin. This is considered to be the acreage normally irrigated during recent years. Figure 7-1 illustrates the relationship between crop consumptive use, effective precipitation and irrigation requirement. In 1964, the growing season precipitation was over 3 inches above average and little irrigation was necessary.

## IRRIGATED LANDS

Nearly 75 percent of the irrigated lands within the Basin are located in the Snohomish Valley and the area just north of Marysville. The remainder is scattered in the Snoqualmie, Skykomish, and Pilchuck River Valleys.

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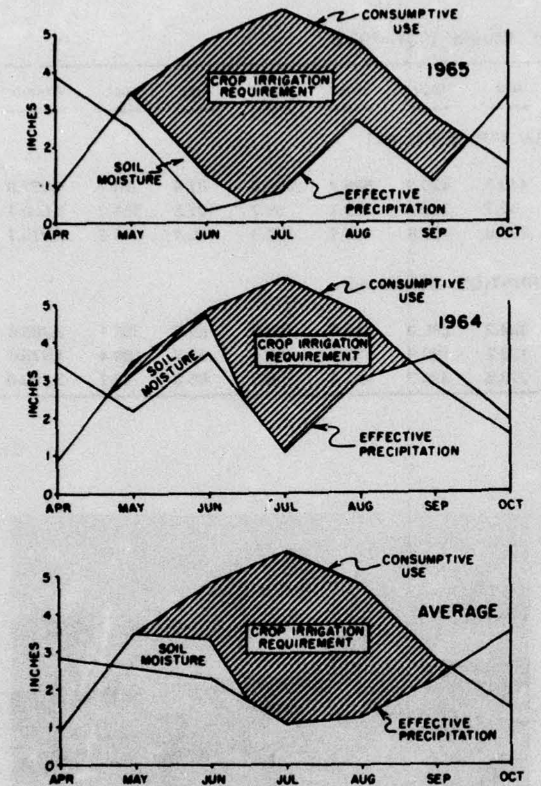



**FIGURE 7-1. Crop irrigation requirements for typical dry, wet, and average years.**

The soils of the Basin were developed in a mild, moist, nearly frost free climate. Alluvial soils predominate on the irrigated lands in the Snohomish, Snoqualmie, and Skykomish areas. In the Marysville area, terrace soils are the most common. Topography of the greater part of the irrigated lands is smooth to undulating with most of the irrigation by sprinkler application.

Presently irrigated lands in the Snohomish Basin were classified (1963 survey) as classes 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 7-2. A summary of the lands irrigated in 1963 is shown below.

| Land Class | Irrigated (acres) |
|---|---|
| 1 | 2,000 |
| 2 | 5,100 |
| 3 | 5,700 |
| Total | 12,800 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Irrigation development has generally occurred in the narrow valleys along the Skykomish, Snoqualmie and Snohomish rivers, where both surface and ground waters are easily obtained. Approximately 75 percent of the irrigated lands receive their water supply from surface diversions and 25 percent from ground water. Surface diversions are primarily from the Skykomish, Snoqualmie, and Snohomish Rivers and their tributaries.

The Snohomish Basin has a relatively large water resource. The annual runoff of the Snohomish River averages over 5.5 million acre-feet. Accurate runoff records are not available because tidal action influences most of the length of the Snohomish River. The Skykomish River near Gold Bar averages 2,879,000 acre-feet annually. The annual runoff of the Snoqualmie River near Carnation averages 2,789,000 acre-feet. The Snohomish River usually has two high flow periods during the year; one of these occurs in fall or winter and one in late spring. Low flows occur in early spring and in the months of August or September. Approximately 55 percent of the annual runoff occurs during April-October. Monthly and annual runoff at selected sites on the Skykomish River and Snoqualmie River are shown in Table 7-1.

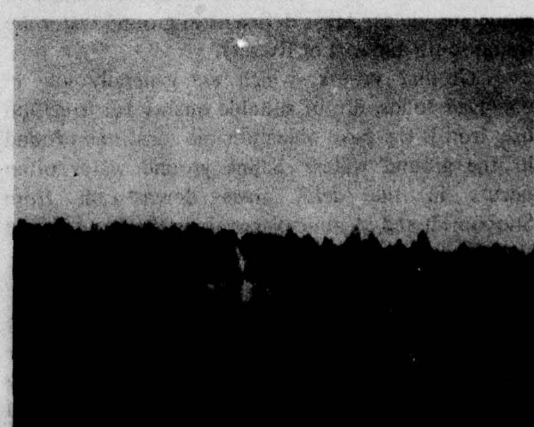


**PHOTO 7-3. Irrigating strawberries in the Pilchuck River Valley. (USBR photo)**

TABLE 7-1. Monthly and annual runoff–1,000's of acre-feet. (Period 1931–1960)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SKYKOMISH RIVER near GOLD BAR: (535 sq. mi.) | | | | | | | | | | | | | |
| Max (1959) | 197.0 | 530.5 | 478.3 | 403.2 | 125.3 | 196.9 | 449.5 | 435.3 | 525.7 | 309.6 | 87.4 | 294.1 | 4,032.8 |
| Min (1941) | 137.6 | 147.5 | 208.2 | 143.6 | 98.1 | 124.2 | 52.7 | 210.6 | 129.1 | 59.7 | 37.6 | 151.2 | 1,600.1 |
| Mean | 185.9 | 278.0 | 308.1 | 232.9 | 175.7 | 189.5 | 277.9 | 437.8 | 405.8 | 222.3 | 83.4 | 81.8 | 2,879.1 |
| SNOQUALMIE RIVER near CARNATION: (603 sq. mi.) | | | | | | | | | | | | | |
| Max (1959) | 188.6 | 531.4 | 469.8 | 517.9 | 184.5 | 258.9 | 404.2 | 368.0 | 313.7 | 160.9 | 62.6 | 305.1 | 3,765.6 |
| Min (1941) | 123.7 | 174.0 | 239.4 | 180.9 | 111.2 | 118.9 | 132.7 | 188.9 | 133.9 | 59.4 | 32.2 | 180.4 | 1,675.6 |
| Mean | 181.3 | 306.8 | 355.7 | 299.9 | 227.5 | 240.1 | 273.5 | 328.2 | 281.4 | 145.6 | 65.3 | 83.7 | 2,789.0 |

Surface waters in the Snohomish Basin are of excellent quality for irrigation. This is evidenced by analysis of samples taken. The water has been used to irrigate for over 40 years with no apparent harmful effects to soils or crops. Sediment transport is small except during periods of high runoff. Few sediment problems have been reported in connection with irrigation use.

Major ground water sources are the silts, sands, and gravels found in the western lowland portions of the Basin. Also, the recent alluvium along the main stream valleys contains ground water in the coarser sand and gravel layers. Wells near Monroe have capacities of over 1,000 gallons per minute. Shallow wells in the vicinity of Marysville have relatively large yields; 200 gallons per minute is pumped from wells 10 to 15 feet deep with very small drawdown. Generally, wells in most other areas have small to moderate yields. Areas deficient in ground water are found south and east of Everett.

Ground waters, which are generally low in dissolved solids, are of suitable quality for irrigation use. Iron is the most objectionable constituent found in the ground waters. Saline ground water often occurs in the delta areas downstream from Snohomish and at some places along the Puget Sound shoreline.

## Water Rights

Irrigation rights comprise only 6 percent of the total combined surface and ground water rights in the Snohomish Basin. There has been no decree involving vested rights in this Basin. A vested right is claimed for the Snoqualmie Falls powerplant on the Snoqualmie River for 2,500 cubic feet per second.

PHOTO 7-4. Level bottom lands of Snohomish River Valley near town of Snohomish. (USBR photo)

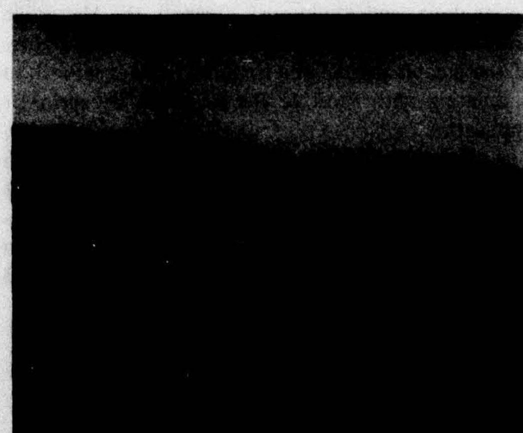
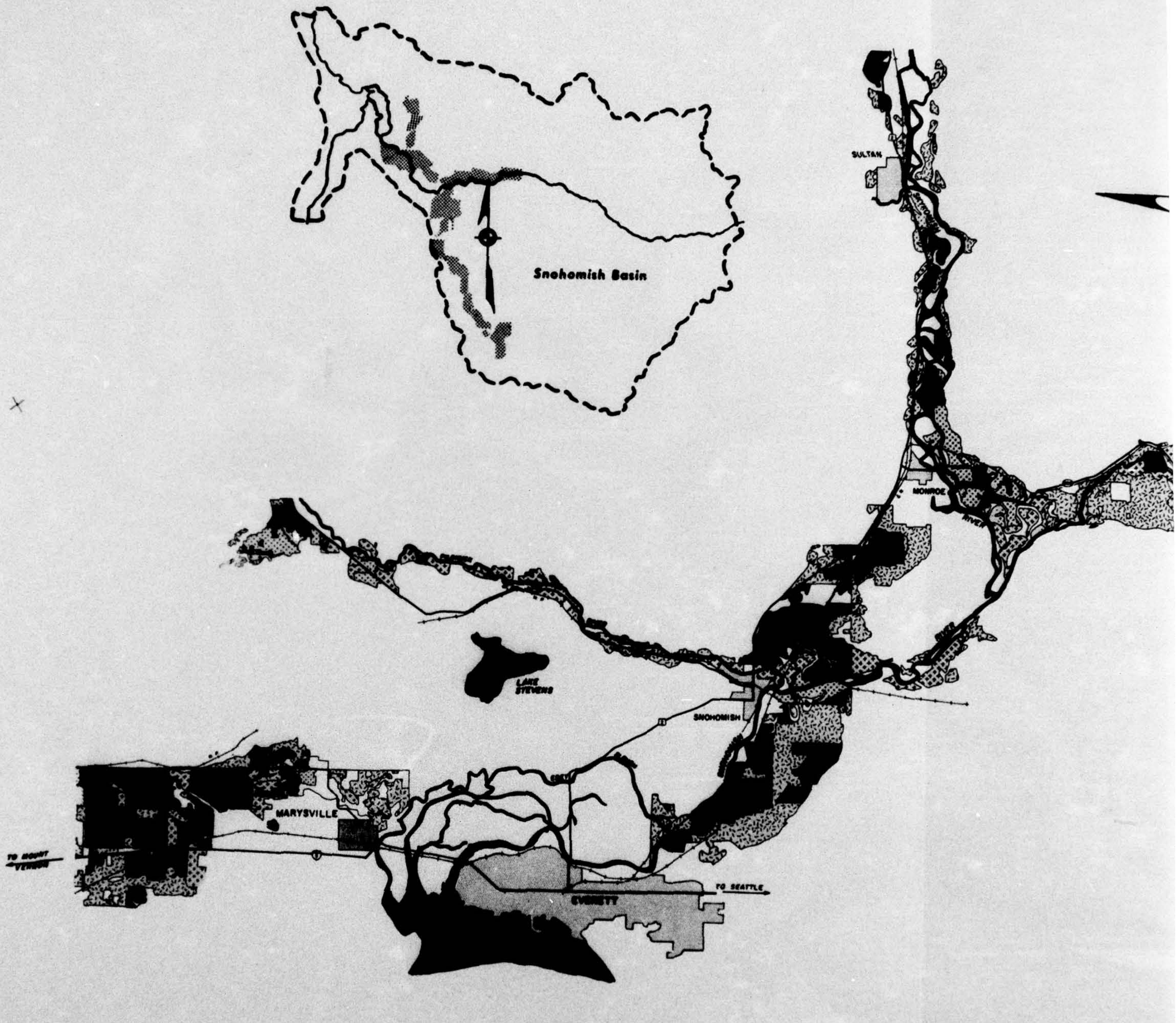


PHOTO 7-5. Irrigation by sprinkler is necessary on the undulating lands east of Everett. (USBR photo)


Snohomish Basin
SULTAN
MONROE
LAKE STEVENS
SNOHOMISH
MARYSVILLE
TO MOUNT VERNON
EVERETT
TO SEATTLE

1967

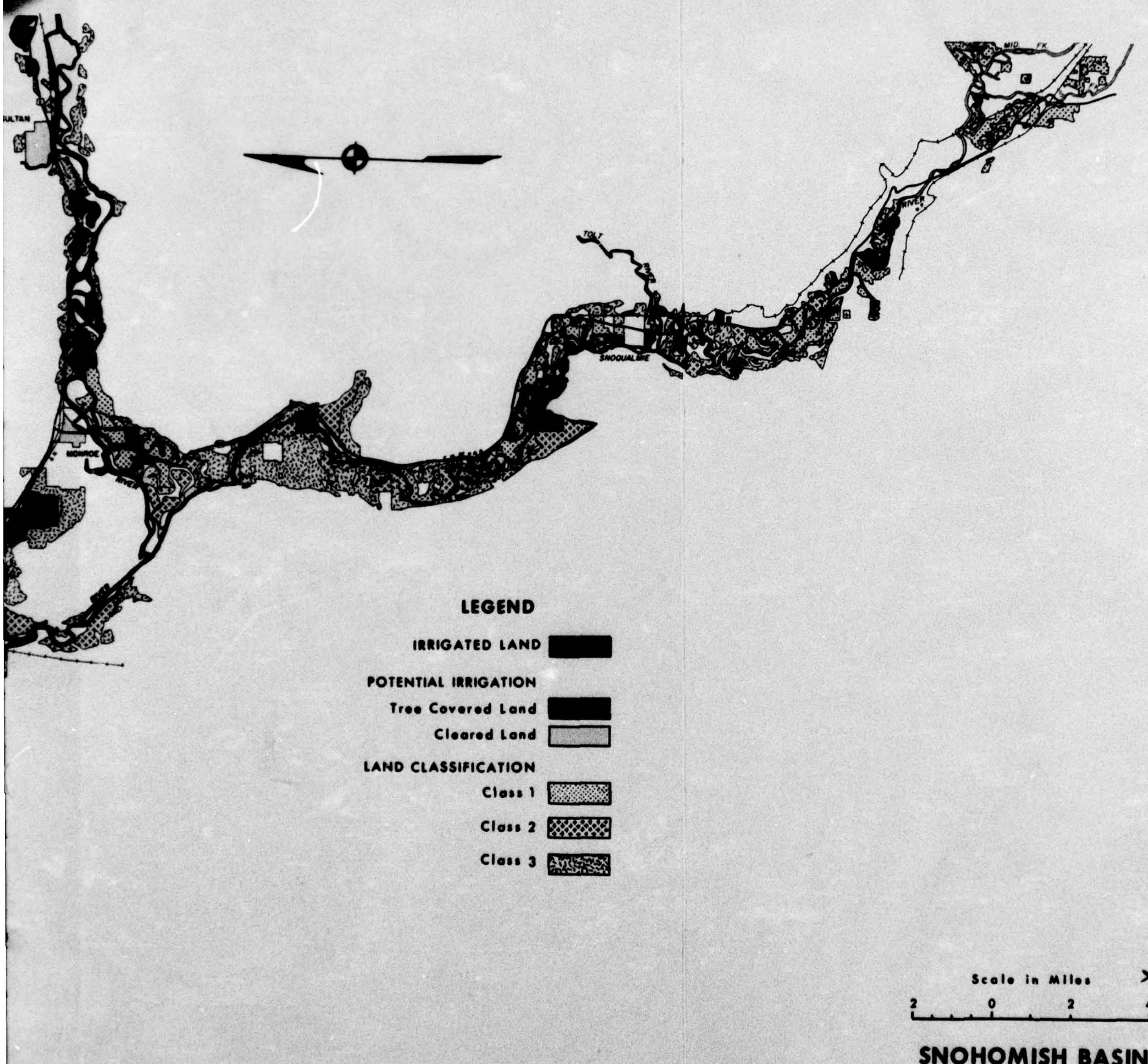



FIGURE 7-2 Irrigation, Snohomish Basin



2

A summary of irrigation right permits and certificates initiated between 1917 and 1967 shows that about 8,800 acres of land have a surface water right. The total maximum diversion to serve this acreage is approximately 81 cubic feet per second.

Irrigation ground water rights, permits and certificates as of September 30, 1966, totaled about 29 cubic feet per second for 2,800 acres.

### Water Requirements

The irrigation water requirements have been estimated using climatological data from two stations–Snoqualmie Falls and Monroe. Summer precipitation is low, averaging 5.4 inches at Snoqualmie Falls and 5.0 inches at Monroe during June through August. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

The annual consumptive use of the irrigated crops is estimated to be about 1.98 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.80 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be about 1.18 acre-feet per acre. With an estimated farm irrigation efficiency of 65 percent, a farm delivery requirement of 1.82 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of five percent of the diverted amount, the presently irrigated lands (12,800 acres) require an average annual diversion of about 24,600 acre-feet. The monthly irrigation requirements are shown in Table 7-2.

The irrigated lands would produce an annual net return flow of 7,600 acre-feet. The resulting depletion of ground and surface water would be 17,000 acre-feet.

### Adequacy of Supply

With few exceptions the quantity of the waters are adequate to meet the present irrigation needs of the Basin. The problems that occur are local in nature, such as the deficiency of ground water in the area south and east of Everett.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $114,000 from increased crop production and $779,000 from increased production of livestock and livestock products for a total value of $893,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964, and field survey information, have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type and Size of Farms

There are about 1,790 farms in the Snohomish Basin. About 130 farms, or seven percent of the total,

**TABLE 7-2. Irrigation requirements**

| Item | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| Distribution | 7% | 19% | 34% | 28% | 12% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .09 | .22 | .40 | .33 | .14 | 1.18 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .13 | .34 | .62 | .51 | .22 | 1.82 |
| Diversion Requirement (Acre-Feet/Acre) | .14 | .36 | .65 | .54 | .23 | 1.92 |

had irrigated cropland in 1964. As shown in Table 7-3, dairy and other livestock farms are the most common farming enterprises in the Basin identified by source of farm income.

TABLE 7-3. Farm types—1964[1]

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crop | 0 | 0 |
| Vegetable | 30 | 1.7 |
| Fruit and Nut | 50 | 1.8 |
| Poultry | 60 | 3.4 |
| Dairy | 285 | 15.9 |
| Other Livestock | 160 | 8.9 |
| General | 15 | .8 |
| Miscellaneous | 1,190 | 66.5 |
| Total | 1,790 | 100.0 |
| | | 100.0 |

[1]Estimated from Census of Agriculture.
[2]Rounded to the nearest 5.

The average size of commercial farms in the Basin is about 80 acres. Farms with irrigated cropland average about 120 acres. Commercial farms with milk cows average about 36 head per farm.

Livestock enterprises make up slightly more than 80 percent of all farm operations. More than 95 percent of the irrigated cropland is in forage crops. Dairy and other livestock farms are the most numerous farms types with irrigated cropland.

## Crops

Total crop production related to irrigation use is shown in Table 7-4.

PHOTO 7-6. Irrigating mint on a farm north of Snohomish. (USBR photo)

TABLE 7-4. Estimated land use and crop production related to irrigation

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre[1] | Increased Production Related to Irrigation: Total[2] |
|---|---|---|---|---|
| Field Crops | | | | |
| Potatoes | 130 | cwt | .45 | 60 |
| Forages | 12,430 | – | – | – |
| Hay | (4,970) | Ton | 1.30 | 6,460 |
| Pasture | (7,460) | AUM | 3.10 | 23,130 |
| Vegetables | 130 | Ton | 1.62 | 210 |
| Broccoli | (10) | Ton | (3.40) | (30) |
| Cauliflower | (20) | Ton | (1.91) | (40) |
| Sweet Corn | (100) | Ton | (1.38) | (140) |
| Berries | 110 | Ton | 2.18 | 240 |
| Strawberries | (60) | Ton | (1.29) | (80) |
| Raspberries | (30) | Ton | (1.41) | (40) |
| Blueberries | (20) | Ton | (6.00) | (120) |
| Total | 12,800 | | | |

[1]See The Puget Sound Area for method of derivation.
[2]Rounded to the nearest 10.

*Irrigated forage crops* are hay and pasture, and these are generally a grass or grass-clover mix. The early crop of grass, generally cut in May, is harvested for silage or green feed, as the weather is too wet to make hay or to graze. Later in the season, this cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basin.

The Snohomish Basin is one of two basins in the Puget Sound Area where mint is grown commercially. Irrigation is necessary to successfully grow this crop. Other field crops grown in the Basin generally are not irrigated.

Most of the mint oil is used by manufacturers and processors for flavoring products sold in regional and national markets.

Irrigated broccoli, cauliflower and sweet corn are commercial vegetable crops grown in the Basin. Other vegetable crops grown commercially generally are not irrigated. Most irrigated vegetables are marketed to processors for canning and freezing.

Strawberries, raspberries and blueberries are commercially important berries that are irrigated. Other berries grown commercially generally are not irrigated. Most strawberries are marketed to local processors for freezing and most blueberries are sold on the fresh market.

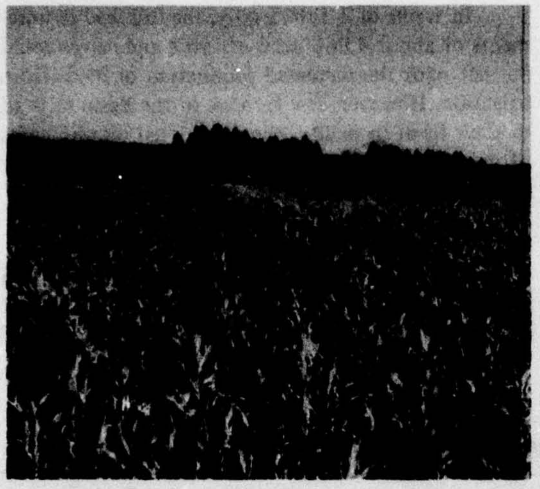


PHOTO 7-7. Corn under irrigation in the valley north of Marysville. (USBR photo)

## Crop Values

Crop values related to irrigation are shown in Table 7-5.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basin. Meat packing and dairy processing plants are located in the Basin. The Basin also has the largest livestock auction yard in the Puget Sound Area. The derivation of estimated animal units of feed requirements and production is shown in Table 7-6.

**TABLE 7-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 14,980 | 25,017 |
| Per Feeder | .58 | 4,980 | 2,888 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 4,320 | 5,486 |
| Per Feeder | .38 | 3,670 | 1,395 |
| Total | | | 34,786 |
| Rounded | | | 34,800 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Unit Production |
|---|---|---|---|
| Forages and Grains | | | |
| Hay—Ton | 6,460 | .20 | 1,292 |
| Pasture—AUM | 23,130 | .08 | 1,850 |
| Small Grains—Ton | -- | -- | -- |
| Corn Silage—Ton | -- | -- | -- |
| Total | | | 3,142 |
| Rounded | | | 3,100 |

[1]Rounded to the nearest 10 head.
[2]Includes feed required for replacements, bulls and young stock normally associated with the breeding herd.
[3]Animal Units of feed per ton/AUM.

**TABLE 7-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value Per Unit[1] (dollars) | Value Total[2] (dollars) |
|---|---|---|---|---|
| Field Crops | Cwt | 60 | 340 | 20,400 |
| Forage | | | | |
| Hay | Ton | 6,460 | 2 | 3 |
| Pasture | AUM | 23,130 | 2 | 3 |
| Vegetables | Ton | 210 | 55 | 11,600 |
| Berries | Ton | 240 | 340 | 81,600 |
| Total | | | | 113,600 |
| Rounded | | | | 114,000 |

[1]Weighted average prices received—adjusted normalized basis

| | | | |
|---|---|---|---|
| Broccoli | $130/Ton | Strawberries | $270/Ton |
| Cauliflower | $ 99/Ton | Raspberries | $330/Ton |
| Sweet Corn | $ 26/Ton | Blueberries | $390/Ton |

[2]Rounded to the nearest $100
[3]Accounted for in livestock and livestock product values.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises, provides about 8.9 percent of the total feed required in the Basin. This relationship is used to determine the proportion of total stock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (T.D.N.) requirements, is shown in Table 7-7. The production is based on 8.9 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 7-6.

In terms of T.D.N.'s only, the full feed requirements of about 4,960 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basin raise all of their feed. In reality, the nutritional requirements of many more than 4,960 head of cattle are partially satisfied by irrigated feeds.

### Livestock and Livestock Product Values

Estimated livestock values related to irrigation are shown in Table 7-8. The value estimates of livestock products are based on the proportion of feed attributable to irrigation.

**TABLE 7-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 17,863 head | 37,857 head | 55,720 head | 8.9 | 4,960 head |
| Milk | 143,984,715 lbs. | --- | 143,984,715 lbs. | 8.9 | 12,814,600 lbs. |
| Butterfat in cream | 46,698 lbs. | --- | 46,698 lbs. | 8.9 | 4,200 lbs. |

[1]Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 7-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 6,779,500 | 1.051 | 7,125,254 | 8.9 | 634,100 |
| Cattle and Calves | 1,551,100 | 1.051 | 1,630,206 | 8.9 | 145,100 |
| Total | | | | | 779,200 |
| Rounded | | | | | 779,000 |

[1]Prices received—Livestock and livestock products

$$\frac{\text{Long-term adjusted normalized index}}{\text{1984 Index}} = \frac{247}{235} = 1.051$$

[2]Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Snohomish Basin total 43,100 acres, of which 12,800 are presently irrigated and 30,300 are potentially irrigable. The lands are located on upland terraces north of Marysville and recent alluvial bottoms along the Snoqualmie, Skykomish and Pilchuck rivers. Projections are that a total of about 20,000 acres will be under irrigation in the Basin by the year 2020.

### Land Characteristics

Soils within this basin have developed under the influence of humid climate and moderate temperature. Surface soil textures are generally medium to fine, of medium grade structure, and friable. Subsoils generally have medium grade, subangular, blocky structure which ranges from friable to firm. The occurrence of water stable aggregates or granules in the soil allows free movement of water through the soil while maintaining a desirable moisture holding capacity. Natural fertility is moderate to high, but addition of fertilizers gives favorable economic returns.

Recent alluvial bottom lands are suited to the production of all crops adapted for the climate of the area, which includes grass and legumes for pasture, strawberries, raspberries, corn, and vegetable crops. Local soil and drainage conditions may limit production to specialized crops in some areas. The higher lying terrace lands are best suited to production of pasture crops, however, some of the adapted general farm crops could also be grown on these lands.

### Land Classes

Potentially irrigable lands in the Snohomish Basin total 30,300 acres, of which 3,200 are presently in woodlands. The following tabulation shows the acreage distribution of potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total |
|---|---|---|---|
| 1 | 6,000 | 100 | 6,100 |
| 2 | 7,100 | 1,100 | 8,200 |
| 3 | 14,000 | 2,000 | 16,000 |
| Total | 27,100 | 3,200 | 30,300 |

Location of these lands is shown on Figure 7-2.

## PROJECTION OF FUTURE IRRIGATION

It is expected that about 11,300 acres of new lands will be under irrigation in the Basin by the year 2020. However, irrigation development is expected to decrease in the area north of Marysville due to urbanization and by 1980 little, if any, irrigation will be practiced in this area. The net result is an increase from the present 12,800 acres irrigated to 20,000 acres.

| Area | Presently Irrigated (acres) | Future Irrigation 1980 (acres) | Future Irrigation 2000 (acres) | Future Irrigation 2020 (acres) | 2020 Total (acres) |
|---|---|---|---|---|---|
| Snoqualmie | 1,900 | 3,300 | 1,300 | 1,300 | 7,800 |
| Skykomish | 1,100 | 600 | 300 | --- | 2,000 |
| Snohomish | 5,000 | 1,500 | 1,700 | --- | 8,200 |
| Pilchuck | 700 | 700 | 600 | --- | 2,000 |
| Marysville | 4,100 | (-4,100) | --- | --- | --- |
| Total | 12,800 | 6,100 | 3,900 | 1,300 | 20,000 |
| Total Accum. Acreage | 12,800 | 14,800 | 18,700 | 20,000 | 20,000 |

Maximum irrigation water requirements for the Basin per acre are:

| | |
|---|---|
| Peak farm delivery requirement | 77 acres/cfs |
| Farm delivery requirement | 1.82 acre-feet/acre |
| Diversion requirement | 1.92 acre-feet/acre |

Monthly distribution of irrigation requirements are shown below as percent of annual demand:

| | |
|---|---|
| May | 7% |
| June | 19% |
| July | 34% |
| August | 28% |
| September | 12% |
| Total | 100% |

It is expected that the water required for the projected acreage in the Snoqualmie, Skykomish, and Pilchuck sub-basins will be diverted entirely from the respective named rivers. In the Snohomish River sub-basin it is estimated that approximately 2,000 acres of the presently irrigated 5,000 acres is supplied from ground water. Acreage served from ground water in this sub-basin is expected to increase to 3,000 acres by 1980 and to 4,000 by the year 2020.

The annual diversion and peak farm delivery requirements necessary to meet irrigation needs in 1980, 2000 and 2020 are tabulated below:

| | Estimated Present | | Surface Diversions 1980 | | 2000 | | 2020 | |
|---|---|---|---|---|---|---|---|---|
| River | ac. ft. | cfs | ac. ft. | Peak cfs | ac. ft. | Peak cfs | ac. ft. | Peak cfs |
| Snoqualmie | 2,700 | 18 | 6,300 | 45 | 2,500 | 20 | 2,500 | 20 |
| Skykomish | 1,700 | 12 | 1,100 | 10 | 600 | 5 | -- | -- |
| Snohomish | 5,800 | 39 | 1,000 | 6 | 1,300 | 9 | -- | -- |
| Pilchuck | 1,000 | 7 | 1,300 | 10 | 1,100 | 10 | -- | -- |
| Marysville | 700 | 5 | -- | -- | -- | -- | -- | -- |

# MEANS TO SATISFY NEEDS

Future irrigation development is expected to take place along the fertile bottom lands and will be dependent upon the type of flood protection provided and flood plain zoning. Snohomish County is studying the possibility of zoning the river bottom lands above the town of Everett as agricultural. Irrigation development most likely will be by private means pumping from the various river systems onto the farm lands. Streamflow records indicate that there is adequate water in the river systems to meet the future irrigation needs of the Basin. However, when other needs of the Basin are considered, storage may be required to meet all these needs. No project-type pumping is contemplated.

The projected investment costs for the Snohomish Basin are shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $820,000 | -- |
| 1980-2000 | $530,000 | -- |
| 2000-2020 | $180,000 | -- |

For the 1980 level of development the annual operating costs are estimated to be $61,000. The operation costs include power, operation, maintenance and replacement costs for the irrigation systems. If upstream storage is required to meet the water supply needs, additional costs would be involved.

The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area, under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $70 per acre and is summarized as follows:

| Year | New Irrigation (acres) | Farmers Increased Annual Income |
|---|---|---|
| 1980 | 6,100 | $427,000 |
| 2000 | 3,900 | 272,000 |
| 2020 | 1,300 | 91,000 |

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

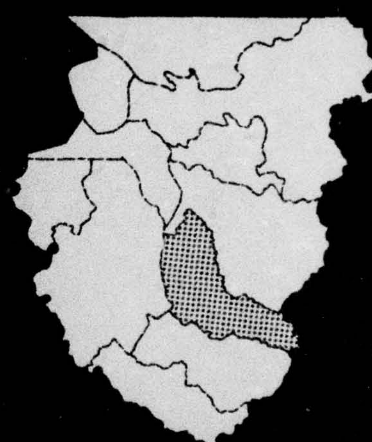
Estimated net depletions of surface and ground water sources associated with present and anticipated irrigation development are shown below:

| | Net Depletions[1] | | | | | | | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present | | 1980 | | 2000 | | 2020 | | Total | |
| River | GW (ac. ft.) | SW | GW (ac. ft.) | SW | GW (ac. ft) | SW | GW (ac. ft.) | SW | GW (ac. ft.) | SW |
| Snoqualmie | 1,900 | 700 | -- | 4,000 | -- | 1,700 | -- | 1,700 | 1,900 | 8,100 |
| Skykomish | 1,200 | 300 | -- | 800 | -- | 400 | -- | -- | 1,200 | 1,500 |
| Snohomish | 4,000 | 2,700 | 1,300 | 700 | 1,300 | 900 | -- | -- | 6,600 | 4,300 |
| Pilchuck | 700 | 300 | -- | 900 | -- | 800 | -- | -- | 700 | 2,000 |
| Marysville | 500 | 4,900 | -- | -- | -- | -- | -- | -- | -- | -- |
| Total | 8,300 | 8,900 | 1,300 | 6,400 | 1,300 | 3,800 | -- | 1,700 | 10,400[2] | 15,900[3] |

| Total Accumulated Depletion (ac. ft.) | Present | 1980 | 2000 | 2020 |
|---|---|---|---|---|
| | 17,200 | 19,500 | 24,600 | 26,300 |

[1] Diversion requirement minus return flow.
[2] Includes 500 acre-foot decrease by 1980 in Marysville drainage.
[3] Includes 4,900 acre-foot decrease by 1980 in Marysville drainage.

# Cedar-Green Basins



# CEDAR-GREEN BASINS

The Cedar-Green Basins lie in the central portion of the Puget Sound Area containing the heavily populated metropolitan area of Seattle and surrounding communities in parts of King and Snohomish counties. Cedar River and Green River Basins are independent basins having their origin in the Cascade Range and flowing indirectly into Puget Sound. A third river, the Sammamish River, which has its origin in Lake Sammamish and the foothills of the Cascade Mountains, flows into Puget Sound through Lake Washington.

Both the Cedar and Green rivers follow a nearly parallel course from the Cascade Mountains between rolling hills of glacial deposits and occasional projections of outcropping rocky knobs. The rivers follow well-defined valleys. The Cedar River follows a narrow valley to emerge directly into Lake Washington at Renton and finally into Puget Sound through the Lake Washington Ship Canal. The Green River flows through a 15-mile gorge before emerging into the broad, alluvial Green-Duwamish Valley near Auburn. The Green River becomes the Duwamish River which enters Puget Sound at Elliott Bay through a dredged channel five miles long.

The climate of the Cedar-Green Basins reflects the moderating effect of maritime air from the Pacific Ocean. A well-defined rainy season begins in November and carries through March with increasing sunshine in April through June to a relatively dry period from July to October.

The average annual precipitation varies from about 35 inches in Seattle to over 100 inches at the crest of the Cascade Range. Heavy snow packs are characteristic of the mountain areas. Stream flows are influenced by melting snow well into the month of July. Snow is rare in Seattle and seldom lasts more than a few days.

A significant segment of the Basins' economy is the aerospace industry. The Boeing Company's facilities in the Seattle-Tacoma-Everett area have expanded tremendously since World War II. Facilities are located at Renton, Kent, Auburn, Seattle and Everett with nearly 100,000 persons employed.

Seattle is an excellent seaport, Seattle harbor (Elliott Bay) providing a natural, deep-water harbor. The 53-mile long waterfront is lined with modern terminals equipped to handle any type of cargo.

Shipbuilding, food processing, metals and other industries provide an important part of the economy of the Cedar-Green Basins. Heavy industrial development is concentrated along the lower reaches of the Green-Duwamish River Valley, along the shores of Elliott Bay, Lake Union, and Salmon Bay, and in the Renton area at the southern end of Lake Washington. Light industry is dispersed throughout the lower areas of the Basins.

**PHOTO 8-1. The Green River Valley looking south from Tukwila. (USBR photo)**

PHOTO 8-2. The city of Auburn expands into the Green River Valley (USBR photo)

Timber and related forest products are produced in the upper reaches of the Basins. The Snoqualmie National Forest, State of Washington Department of Natural Resources, Seattle Water Department and private timber companies, control substantial forest lands which are operated on a sustained yield basis. Forest products are an important contribution to the local economy.

Agricultural development is concentrated in the valleys of the Green, Cedar, and Sammamish rivers with some marginal development in the upland areas. More than 80 percent of the cropland is devoted to forage production.

Dairying and truck farms are the chief supports of the agricultural economy in these fertile valleys. The lowlands are utilized for grazing dairy cattle, a few chicken ranches, and vegetable and berry farms. The rapid influx of people into these areas is replacing farmlands with housing subdivision, shopping centers, and freeways. Industrial encroachment is further eliminating agricultural land.

The following tabulation epicts present land use within the Basins:

| | Acres |
|---|---|
| Cropland | 53,000 |
| Rangeland | 3,000 |
| Forest | 447,000 |
| Rural nonagricultural | 34,000 |
| Built-up areas | 167,000 |
| TOTAL | 704,000 |

Seattle, the largest city in the State, with a population of 580,000 (1967) within its corporate limits is the center of population within the Basins. The total population of the Basins is about 1,072,400. This population is highly concentrated around Seattle and in the lower areas of the Basins.

# PRESENT STATUS

Development of irrigation has been concentrated along the Green and Sammamish rivers and, to a lesser extent, along the Cedar River. Irrigation has been decreasing during the past few years due to the expansion of housing and industry into these valleys.

Irrigation use varies yearly depending upon the amount of growing season rainfall. In 1966, about 2,600 acres were irrigated in the Cedar-Green Basins. This is considered to be the acreage normally irrigated during recent years.

Figure 8-1 illustrates the relationship between crop consumptive use, effective precipitation, and irrigation requirements.

## IRRIGATED LANDS

Irrigated lands within the Basins are situated mainly in the lower reaches of the Cedar and Green rivers and in the Sammamish River Valley. These areas are rapidly changing from farming to urban areas and the irrigated acreage is expected to continue to decrease in the future.

Soils within the Basins have developed on recent alluvial and peat deposits under the influence of humid climate and moderate temperature. The soils are suitable for the production of all crops adapted to the climatic conditions in the area.

The topography is generally flat to slightly undulating, and is well adapted to sprinkler irrigation in the lower portions of the Basins.

Most of the 2,600 acres irrigated are projected to be supplanted with urban development. Therefore, only 300 acres along the upper part of the Green River were classified. These lands were classified as class 1 or 2, depending upon their relative suitability for irrigation development. Of the 300 acres, 40 percent are Class 1 and the remainder Class 2. An explanation of land classification procedures and criteria used in this study is given in the section of the

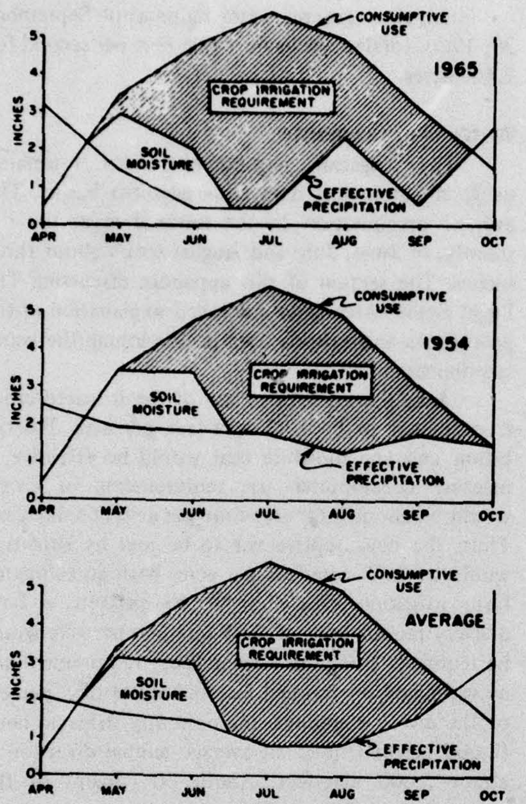



**FIGURE 8-1. Crop irrigation requirements for typical dry, wet, and average years.**

appendix which discusses The Puget Sound Area.

The location of irrigated land (1966 survey) is shown on Figure 8-2.

## WATER RESOURCES

### Water Supply

Water supply for the irrigated lands is obtained from wells and individual diversions from the Sammamish, Duwamish, Green, and Cedar rivers and their tributaries. About 20 percent of the lands receive their water supply from ground water and 80 percent from surface sources.

The Cedar-Green Basins have a relatively large surface water resource. The average monthly and annual runoff of these three rivers is shown in Table 8-1 along with data for extreme years.

The Cedar and Green rivers usually have two periods of high runoff: one in December or January and one during April, May and June. The lowest runoff occurs in August and September. Seasonal runoff patterns in the Sammamish River drainage are comparable to other rain-fed streams of the Puget Sound lowlands.

Surface water is of excellent quality for irrigation, and has been used for over 40 years without harmful effects to soils or crops. High sediment transport rates are generally associated with high runoff rates during the non-irrigation season, therefore few problems are encountered with sediment in irrigation use.

**TABLE 8-1. Monthly and annual runoff—1000's of acre-feet (Period 1931-1960)**

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREEN RIVER NEAR PALMER: (230 sq. mi.) | | | | | | | | | | | | | |
| Max (1959) | 48.5 | 195.3 | 158.7 | 163.1 | 51.2 | 75.4 | 110.7 | 101.1 | 58.5 | 25.3 | 12.8 | 88.5 | 1,089.1 |
| Min (1941) | 13.8 | 43.4 | 65.4 | 45.0 | 29.0 | 32.0 | 37.5 | 32.6 | 27.2 | 12.7 | 8.9 | 22.2 | 369.7 |
| Mean | 37.9 | 93.1 | 108.9 | 88.7 | 67.6 | 76.7 | 98.8 | 102.4 | 64.7 | 25.7 | 12.2 | 14.6 | 781.3 |
| CEDAR RIVER NEAR LANDSBURG: (117 sq. mi. ) | | | | | | | | | | | | | |
| Max (1934) | 34.2 | 67.0 | 192.2 | 123.8 | 48.9 | 57.2 | 49.9 | 33.1 | 27.6 | 20.5 | 15.9 | 13.1 | 683.4 |
| Min (1941) | 15.6 | 18.5 | 25.4 | 24.5 | 21.9 | 22.2 | 20.0 | 20.4 | 21.4 | 19.2 | 16.9 | 20.1 | 246.1 |
| Mean | 23.6 | 39.5 | 56.3 | 56.5 | 46.6 | 50.3 | 47.7 | 49.3 | 46.3 | 31.9 | 24.0 | 20.5 | 492.5 |
| SAMMAMISH RIVER AT BOTHELL: (209 sq. mi.)* | | | | | | | | | | | | | |
| Max (1948) | 16.8 | 36.1 | 42.7 | 59.2 | 42.4 | 45.4 | 35.2 | 34.2 | 24.7 | 15.2 | 11.0 | 10.9 | 373.8 |
| Min (1941) | 8.6 | 13.6 | 20.4 | 27.0 | 20.4 | 17.9 | 16.2 | 12.1 | 9.2 | 5.7 | 4.5 | 7.0 | 162.6 |
| Mean | 9.8 | 18.4 | 34.5 | 41.4 | 41.2 | 38.0 | 28.2 | 20.2 | 12.9 | 8.7 | 6.4 | 6.4 | 266.1 |

* Period 1940-1960.

**PHOTO 8-3. Irrigated celery near Bothell. Urban expansion is evidenced by community swimming pool in background. (USBR photo)**

The use of ground water for irrigation occurs mostly in the lower Green River Valley and on the plateau east of Auburn, south of the Green River. Moderate to large yields are obtainable in this vicinity. Generally, the remaining area of the basins has low to moderate yields depending upon the materials that comprise the aquifer. Observations of well levels indicate that generally the rate of recharge exceeds the rate of withdrawal from the aquifers. However, in scattered areas where many small communities are using the wells extensively the ground water levels are lowering. Ground water quality is satisfactory for irrigation use. Ground waters are usually more highly mineralized than surface waters and incidental sea-water encroachment has occurred in localized areas near the Puget Sound.

## Water Rights

There has been no adjudication for the use of water in the Cedar-Green Basins.

As of September 1, 1967, there were over 10,000 acres of land which had an application, a permit or a certificate for a surface water right. The total diversion to serve this acreage along with combined rights for stock and domestic water is approximately 140 cubic feet per second.

Increased water use in recent years has created additional conflicts of interest. Several of the smaller streams and tributaries have been closed to further appropriation while a few others are subject to designated low-flow restrictions.

Irrigation ground water rights as of September 20, 1966, totaled about 43 cubic feet per second for 2,400 acres.

## Water Requirements

The irrigation requirements were estimated using climatological data from adjacent basins. The average precipitation in the lowland areas for the months of June, July and August totals about three inches. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

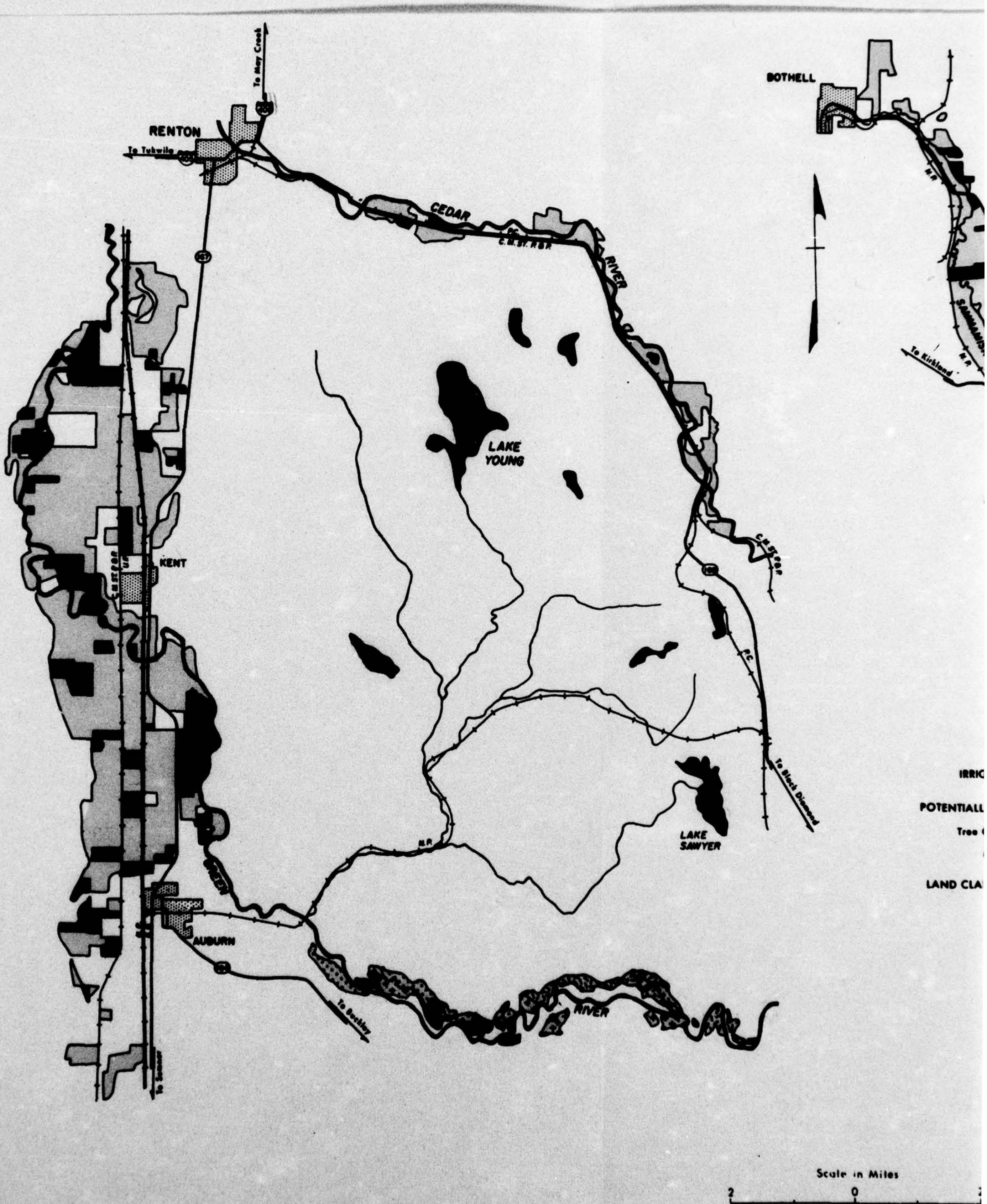
Annual consumptive use of the irrigated crops is estimated to be 1.97 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops, would be about 0.69 acre-foot per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.28 acre-feet per acre. With an estimated farm irrigation efficiency of 63 percent, a farm delivery requirement of 2.04 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of 5 percent of the diverted amount, the presently irrigated lands (2,600 acres) require an average annual diversion of about 5,600 acre-feet. About 80 percent of this comes from surface sources.

The monthly irrigation requirements are presented in Table 8-2.

**TABLE 8-2. Irrigation Requirements**

| Item<br>Distribution | May<br>4% | June<br>20% | July<br>33% | Aug<br>29% | Sep<br>14% | Total<br>100% |
|---|---|---|---|---|---|---|
| Crop Irrigation Requirement (Acre-Ft/Acre) | .05 | .26 | .42 | .37 | .18 | 1.28 |
| Farm Delivery Requirement (Acre Ft/Acre) | .08 | .41 | .67 | .59 | .29 | 2.04 |
| Diversion Requirement (Acre Ft/Acre) | .09 | .43 | .71 | .62 | .30 | 2.15 |

The normally irrigated lands (2,600 acres) would produce an annual return flow approximating 1,800 acre-feet resulting in a 3,800 acre-foot annual depletion of ground and surface waters.



RENTON
To May Creek
To Tukwila
CEDAR
RIVER
C.M.ST.P.&P.R.R.
BOTHELL
To Kirkland
SAMMAMISH
LAKE YOUNG
KENT
LAKE SAWYER
To Black Diamond
AUBURN
To Buckley
RIVER
To Sumner
IRRIG
POTENTIALL
LAND CLA
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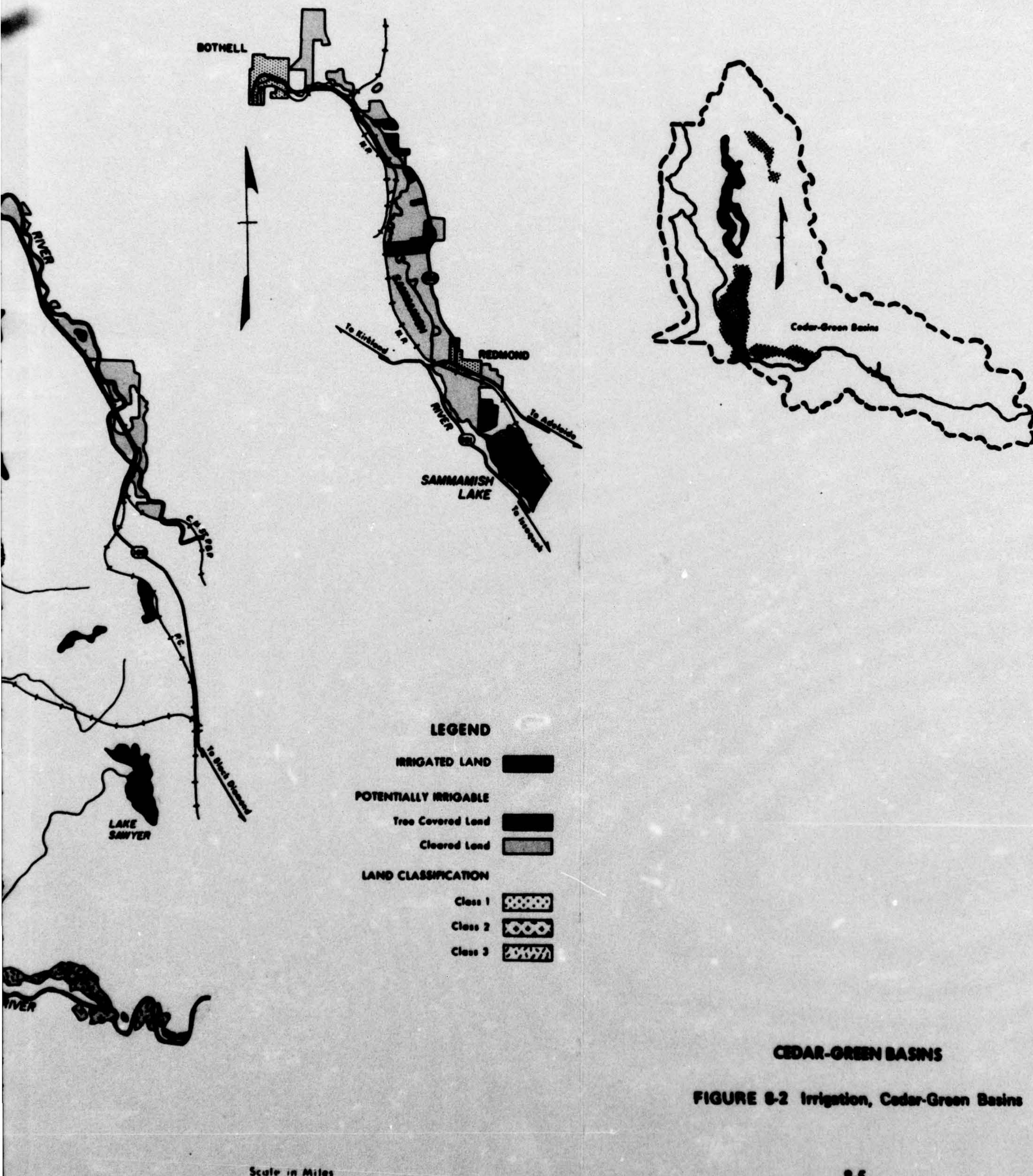



CEDAR-GREEN BASINS

FIGURE 8-2 Irrigation, Cedar-Green Basins



2

### Adequacy of Supply

With few exceptions the quantity of the waters in the Cedar-Green Basins are adequate to meet the present irrigation needs of the area. Some local problems may be experienced in the adequacy of ground water in highly urbanized areas near Puget Sound.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average growing season. These incremental values are $530,000 from increased crop production and $49,000 from increased production of livestock and livestock products for a total value of $579,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basin Data

Agricultural Census data for 1964, and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 1,190 farms in the Cedar-Green Basins. In 1964, 70 farms, or about six percent, had irrigated cropland. As shown in Table 8-3, dairy and other livestock farms are the most common farming enterprises in the Basins identified by source of farm income.

The average size of commercial farms is about 60 acres and farms with irrigated cropland average about 50 acres. Commercial farms with milk cows average 44 cows per farm.

Although livestock operations are the most numerous farming enterprises in the Basins, over 65 percent of the irrigated cropland is used for vegetable and berry production. Forage crops are grown on the remaining irrigated cropland.

PHOTO 8-4. Typical irrigation diversion from Sammamish River. (USBR photo)

TABLE 8-3. Farm Types—1964[1]

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crop | 0 | 0 |
| Vegetable | 40 | 3.4 |
| Fruit and Nut | 35 | 2.9 |
| Poultry | 50 | 4.2 |
| Dairy | 185 | 15.6 |
| Other Livestock | 120 | 10.1 |
| General | 10 | .8 |
| Miscellaneous | 750 | 63.0 |
| TOTAL | 1,190 | 100.0 |

1 Estimated from Census of Agriculture
2 Rounded to the nearest 5.

### Crops

Total crop production related to irrigation use is shown in Table 8-4.

Over 60 percent of the irrigated cropland in the Basins is used for vegetable production. Large population centers and processors in and near the Basins provide market outlets for these crops. Snap beans, broccoli, cabbage, cauliflower, celery, sweet corn, cucumbers, fall lettuce and rhubarb are commercially important vegetables that are irrigated. Celery, lettuce and rhubarb go to fresh markets. Sweet corn, broccoli and cauliflower go to both fresh markets and processors. Most of the snap beans, cabbage and cucumbers are marketed to processors. Other vegetables grown commercially generally are not irrigated.

**TABLE 8-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Measured Production Related to Irrigation Per Acre[1] | Total[2] |
|---|---|---|---|---|
| **Forages** | 880 | -- | -- | -- |
| Hay | (300) | Ton | 1.25 | 380 |
| Pasture | (580) | AUM | 2.98 | 1,730 |
| **Vegetables** | 1,580 | Ton | 2.83 | 4,560 |
| Snap Beans | (550) | Ton | (3.64) | (2,000) |
| Broccoli | (20) | Ton | (5.25) | (100) |
| Cabbage | (240) | Ton | (4.50) | (1,080) |
| Cauliflower | (50) | Ton | (1.50) | (80) |
| Celery | (160) | Ton | (2.15) | (340) |
| Sweet Corn | (70) | Ton | (1.50) | (100) |
| Cucumbers | (50) | Ton | (8.00) | (400) |
| Lettuce-Fall | (320) | Ton | (1.15) | (370) |
| Rhubarb | (120) | Ton | (.75) | (90) |
| **Berries** | 140 | Ton | 2.64 | 370 |
| Strawberries | (80) | Ton | (1.60) | (130) |
| Raspberries | (30) | Ton | (2.26) | (70) |
| Blueberries | (30) | Ton | (6.00) | (180) |
| TOTAL | 2,600 | | | |

1 See The Puget Sound Area for method of derivation
2 Rounded to the nearest 10

Forage crops are grown on about 35 percent of the irrigated cropland. Most of this acreage is in grass or grass-clover crops used for hay, pasture and green feed. The early crop, generally cut in May, is harvested for silage or green feed since the weather is too wet to make hay or to graze. Later in the season, it is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basins.

Strawberries, raspberries and blueberries are grown on about five percent of the irrigated cropland. Most strawberries and raspberries are marketed to processors in and near the Basins for canning and freezing. Blueberries are sold on the fresh market in the Pacific Northwest and throughout the West Coast. Other berries grown commercially generally are not irrigated.

## Crop Values

Crop values related to irrigation are shown in Table 8-5.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basins. Meat pack-

**TABLE 8-5. Estimated crop values related to irrigation.**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value Per Unit[1] (dollars) | Total[2] (dollars) |
|---|---|---|---|---|
| **Forages** | | | | |
| Hay | Ton | 380 | | 3 |
| Pasture | AUM | 1,730 | | 3 |
| **Vegetables** | Ton | 4,560 | 88 | 401,300 |
| **Berries** | Ton | 380 | 340 | 129,200 |
| **Total** | | | | 530,500 |
| **Rounded** | | | | 530,000 |

1 Weighted average prices received–adjusted normalized basis

| | | | |
|---|---|---|---|
| Snap Beans | -$130/Ton | Cucumbers | -$ 63/Ton |
| Broccoli | -$130/Ton | Lettuce | -$ 59/Ton |
| Cabbage | -$ 38/Ton | Rhubarb | -$ 89/Ton |
| Cauliflower | -$ 99/Ton | Strawberries | -$270/Ton |
| Celery | -$ 73/Ton | Raspberries | -$330/Ton |
| Sweet Corn | -$ 26/Ton | Blueberries | -$390/Ton |

2 Rounded to the nearest $100
3 Accounted for in livestock and livestock product values.

PHOTO 8-5. Irrigated lettuce near Bothell. (USBR photo)

ing and dairy processing plants are located at Seattle. Seattle also provides the market for most of the livestock products from the Basins. The derivation of estimated animal units of feed requirements and production is shown in Table 8-6.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 0.7 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (TDN) requirements, is shown in Table 8-7. The production is based on 0.7 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 8-6.

In terms of TDN's only, the full feed requirements of about 270 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all of their feed. In reality, the nutritional requirements of many more than 270 head of cattle are partially satisfied by irrigated foods.

TABLE 8-6. Estimated feed requirements and production

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 10,760 | 17,969 |
| Per Feeder | .58 | 8,350 | 4,843 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 2,700 | 3,429 |
| Per Feeder | .38 | 2,960 | 1,125 |
| Total | | | 27,366 |
| Rounded | | | 27,400 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Unit Production |
|---|---|---|---|
| Forages & Grain | | | |
| Hay-Ton | 380 | .20 | 76 |
| Pasture-AUM | 1,730 | .08 | 138 |
| Small Grains-Ton | -- | -- | -- |
| Corn silage-Ton | -- | -- | -- |
| Total | | | 214 |
| Rounded | | | 200 |

[1] Rounded to the nearest 10 head.
[2] Includes the normal number of replacement stock and bulls on a per head basis.
[3] Animal Units of feed per ton/AUM.

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 8-8. The value estimates are based on the proportion of feed attributable to irrigation.

TABLE 8-7. Estimated production of livestock and livestock products related to irrigation

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 13,280 head | 25,790 head | 39,070 head | 0.7 | 270 head |
| Milk | 111,695,600 lbs. | | 111,695,600 lbs. | 0.7 | 781,900 lbs. |
| Butterfat in cream | 24,900 lbs. | | 24,900 lbs. | 0.7 | 200 lbs. |

[1] Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 8-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 5,206,000 | 1.051 | 5,471,086 | 0.7 | 38,300 |
| Cattle & Calves | 1,451,300 | 1.051 | 1,525,316 | 0.7 | 10,700 |
| Total | | | | | 49,000 |
| Rounded | | | | | 49,000 |

[1] Prices received—Livestock and Livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1964 Index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Cedar-Green Basins total 13,990 acres, of which 2,640 acres are presently irrigated and 11,350 are potentially irrigable. These potentially irrigable lands are located in the Sammamish River Valley and along the lower reaches of the Cedar and Green Rivers. About 1,100 acres along the upper part of the Green River are the only lands expected to be irrigated in the future. These lands are on the alluvial flood plain of the Green River Valley.

### Land Characteristics

Soils within the Basins have developed under the influence of humid climate and moderate temperature. They are on recent alluvial deposits and are suited to the production of all crops adapted to the climatic conditions of the area which includes grass and legumes for pasture, specialty and vegetable crops and field crops such as alfalfa and potatoes.

The topography is generally quite smooth and well adapted to sprinkler irrigation.

About 120 acres of the potentially irrigable lands have drainage problems of varying degrees. Generally, lands can be improved by construction of shallow surface drains and improvement of natural channels for removal of heavy winter precipitation.

### Land Classes

The lands in the Sammamish River Valley and the lower reaches of Cedar and Green rivers were not covered by land classification. Only present land use was mapped because these lands are expected to be absorbed by urban and industrial expansion in the near future.

Potentially irrigable lands along the upper part of the Green River total 1,040 acres, of which 50 acres are in woodlands. The following tabulation shows the acreage distribution of these lands by land classes:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 240 | 0 | 240 |
| 2 | 430 | 40 | 470 |
| 3 | 320 | 10 | 330 |
| Total | 990 | 50 | 1,040 |

Location of these lands is shown on Figure 8-2.

## PROJECTION OF FUTURE IRRIGATION

The crops grown in the fertile soils of the bottom lands lying north of Auburn and between Bothell and Lake Sammamish are intensively farmed and irrigated. However, irrigation has been steadily decreasing during the past few years due to the rapid expansion of housing and industry into the irrigated areas. The Basins have 11,350 acres that are not presently irrigated that are capable of sustaining irrigation. However, residential and industrial en-

**PHOTO 8-6. Industrial expansion near Kent is rapidly replacing irrigated pasture lands. (USBR photo)**

croachment into these potential-development areas is expected to continue and will limit new irrigation development. Expectations are that the irrigated acreage in the Basins will decrease from the present 2,600 acres to 300 acres in the near future. However, by the year 2020, 800 acres of new lands are expected to be irrigated. The net result is a decrease from the present 2,600 acres irrigated to 1,100 acres by 2020.

Maximum irrigation water requirements per acre in the Basins are:

| | |
|---|---|
| Peak farm delivery requirement | 73 acres/cfs |
| Farm delivery requirement | 2.04 acre-feet/acre |
| Diversion requirement | 2.15 acre-feet/acre |

Monthly distribution of the irrigation requirement is shown as percent of annual demand.

| | |
|---|---|
| May | 4% |
| June | 20% |
| July | 33% |
| August | 29% |
| September | 14% |
| TOTAL | 100% |

## MEANS TO SATISFY NEEDS

Water supplies for new lands projected to be irrigated along the Green River probably will come from the Green River. Streamflow records indicate that there is adequate water in the river to meet the future irrigation needs. However, when other water needs are considered, storage may be required to meet all requirements. Net depletion of the water supply in the Green River Valley to meet irrigation needs in the future will be about 1,600 acre-feet annually

Present and future irrigation water demands and net depletion of both ground and surface water sources are shown in the following tabulation:

| Year | Total Accumulated Acreage | Total Accumulated Diversion SW (ac.ft.) | Total Accumulated Diversion GW (ac.ft.) | Total Accumulated Depletion (ac. ft.) |
|---|---|---|---|---|
| Present | 2600 | 4500 | 1100 | 3800 |
| 1980 | 1800 | 3100 | 800 | 2600 |
| 2000 | 900 | 1500 | 400 | 1300 |
| 2020 | 1100 | 2000 | 400 | 1600 |

Lands projected to be irrigated likely will be developed by individual pumping from the Green River. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

The Projected irrigation investment costs for the Green Basin is shown below.

| | Private | Federal |
|---|---|---|
| Present-1980 | -- | -- |
| 1980-2000 | $55,000 | -- |
| 2000-2020 | $55,000 | -- |

**Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $223 per acre, and are summarized as follows:**

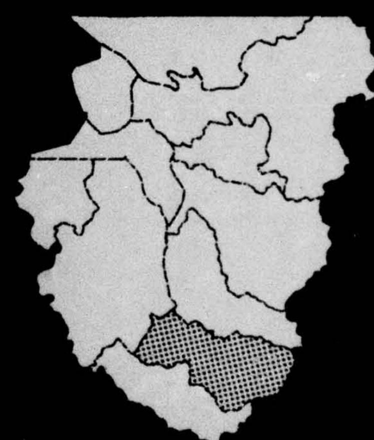
**PHOTO 8-7. Potentially irrigable lands along the Green River. Looking east from Auburn. (USBR photo)**

| Year | New Irrigation (acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | -- | -- |
| 2000 | 400 | $89,000 |
| 2020 | 400 | 89,000 |

This high value is a direct result of small, highly intensified truck-vegetable farming.

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

# Puyallup Basin



# PUYALLUP BASIN

The Puyallup Basin is located in the southern portion of the Puget Sound Area. The Basin lies largely in Pierce County but also contains a small portion of King County. It covers a land and water area of 1,254 square miles with elevations ranging from sea level to over 14,000 feet at the summit of Mt. Rainier.

The Puyallup River and its major tributaries originate in the glaciers of Mt. Rainier and drain an area of 972 square miles. The Puyallup River drops through rugged mountain forests for 20 miles and then meanders 26 miles across a broad glacial outwash plain before flowing into Commencement Bay at Tacoma. The White River drains 494 square miles along the eastern and northern boundaries of the Basin.

The climate of the Basin is typical of the Puget Sound Area with relatively cool summers and mild winters. Average annual precipitation ranges from 40 inches near the mouth of the Puyallup River to 120 inches or more on Mt. Rainier. Only 25 percent or 10 inches, of the annual precipitation occurs during the six month period April through September. Heavy snow packs occur in the Cascade Range forming glaciers on Mt. Rainier that feed the major rivers. The growing season in the lower valley ranges from 165 to 190 days.

Land use changes from intense residential and industrial at Tacoma to cropland in the river valleys and to woodlands in the eastern part of the Basin. Woodland use predominates with about 78 percent of the Basin in forests. Most of the woodland area is in Federal ownership in Mt. Rainier National Park and the Snoqualmie National Forest. Land use is shown as follows:

| | Acres |
|---|---|
| Cropland | 37,000 |
| Rangeland | 6,000 |
| Forest | 593,000 |
| Rural nonagricultural | 26,000 |
| Built-up areas | 97,000 |
| TOTAL | 759,000 |

The economy of the Puyallup Basin is based primarily on trade and manufacturing. The forest products industry is the most important industry,

**PHOTO 9-1. The Puyallup Valley looking southeast toward Mt. Rainier. City of Puyallup at central right. (USBR photo)**

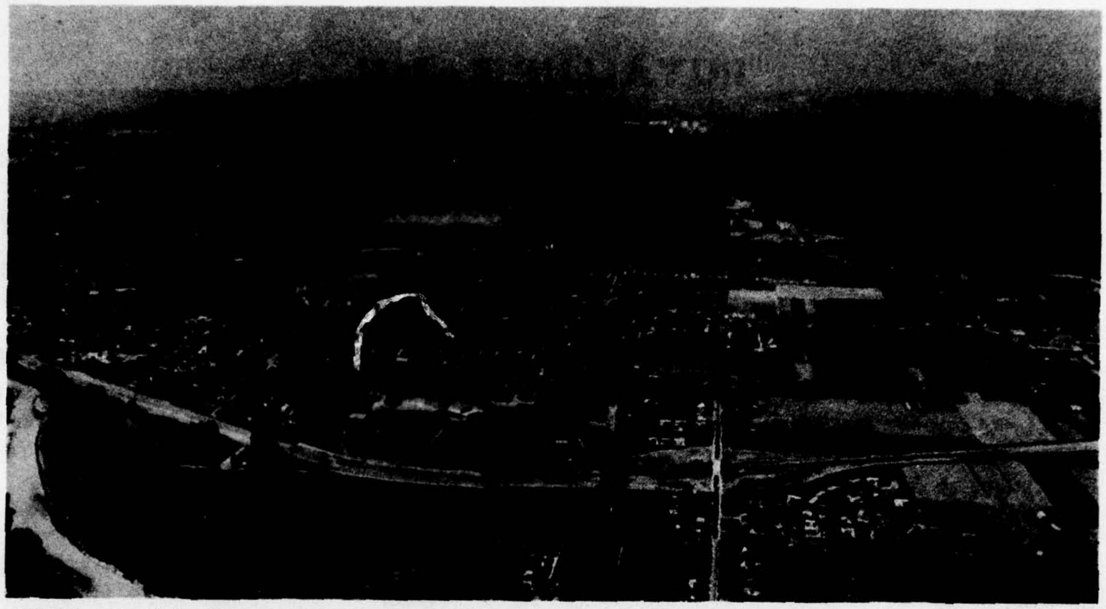


PHOTO 9-2. White River Valley near the confluence with the Puyallup River. Sumner in foreground—looking north toward Auburn. (USBR photo)

with food and associated products the second. The Port of Tacoma industrial district is steadily expanding and has over 3,300 acres of industrial park land with some 320 acres in marine terminal facilities.

Agriculture is centered around poultry, dairying, and intensive horticultural farming. Rhubarb and raspberry production and production of ornamental plants, shrubs, and trees are important to the agricultural economy of the Basin. About one-third of Washington's supply of chicken fryers is produced here. Croplands are subject to depletion from urban build-up. However, with increased demand for foodstuffs, marginal lands will be converted to croplands and increased yields will be developed through irrigation.

There were about 349,800 people living in the Basin in 1967. Tacoma, the largest city, had a population of 156,000. Puyallup had 14,200, Sumner 3,950, and Milton 2,600. The Fort Lewis Military Reservation occupies a substantial area of the lower Basin.

## PRESENT STATUS

Agricultural development in the Puyallup Basin dates back to the early 1840's when large numbers of cattle and sheep were grazed near Steilacoom. Irrigation has developed where adequate water supplies can be easily obtained, and this has been primarily along the Puyallup and White River valleys and in scattered patches near Enumclaw and south of Tacoma. In 1966, about 3,700 acres were irrigated in the Basin. This is considered to be the acreage normally irrigated. Figure 9-1 illustrates the relationship between crop consumptive use, effective precipitation and irrigation requirements.

### IRRIGATED LANDS

Soils within the Puyallup Basin have developed under the influence of humid climate and moderate temperatures, typical of soil development in Western

**PHOTO 9-3. Puyallup Valley south of Sumner. (USBR photo)**

Washington. Soil textures range from very light loamy sands to heavy clay loams to silty clay loams. The presently irrigated lands occupy areas with an easily available water supply. They are not concentrated, but are scattered in relatively small patches throughout the area. Irrigation is used in many areas to maintain full production during the dry summer months although there is adequate rainfall during the remainder of the year.

Irrigated lands were mapped as Class 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown in Figure 9-2. A summary of the lands irrigated in 1966 follows:

| Land Class | Irrigated (acres) |
|---|---|
| 1 | 60 |
| 2 | 2,330 |
| 3 | 1,330 |
| TOTAL | 3,720 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Irrigation has developed principally in the Puyallup and White river valleys. There is also some irrigation in scattered areas in the vicinity of Enumclaw and south of Tacoma. The water supply for irrigated lands is obtained from wells and individual diversions from the Puyallup and White rivers and their tributaries. About 40 percent of the irrigated lands receive their water supply from ground water and 60 percent from surface sources.

The Puyallup Basin has a large surface water resource. The Puyallup River at Puyallup discharges nearly 2,500,000 acre-feet annually. The largest

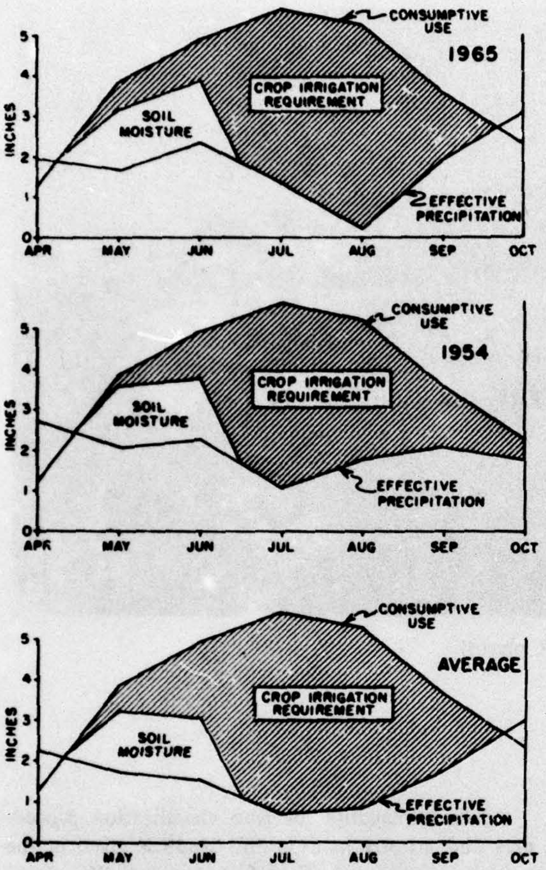



**FIGURE 9-1. Crop irrigation requirements for typical dry, wet, and average years.**

tributary of the Puyallup River is the White River. Its annual runoff averages 1,092,000 acre-feet. Average monthly and annual runoff at selected sites in the Puyallup Basin are shown in Table 9-1.

Two peak flow periods are evident, one in winter followed by another in late spring. The lowest flow occurs in late summer (August and September) although the summer flows are well sustained by glacial melt. Approximately 55 percent of the annual runoff occurs during the April-October growing season.

The surface waters are of excellent quality for irrigation use. The water has been used for irrigation for over 40 years without harmful effects to soils or crops. Much of the suspended sediment carried by both the Puyallup and White rivers is derived from melting glaciers. This glacial sediment causes few problems when the water is used for irrigation.

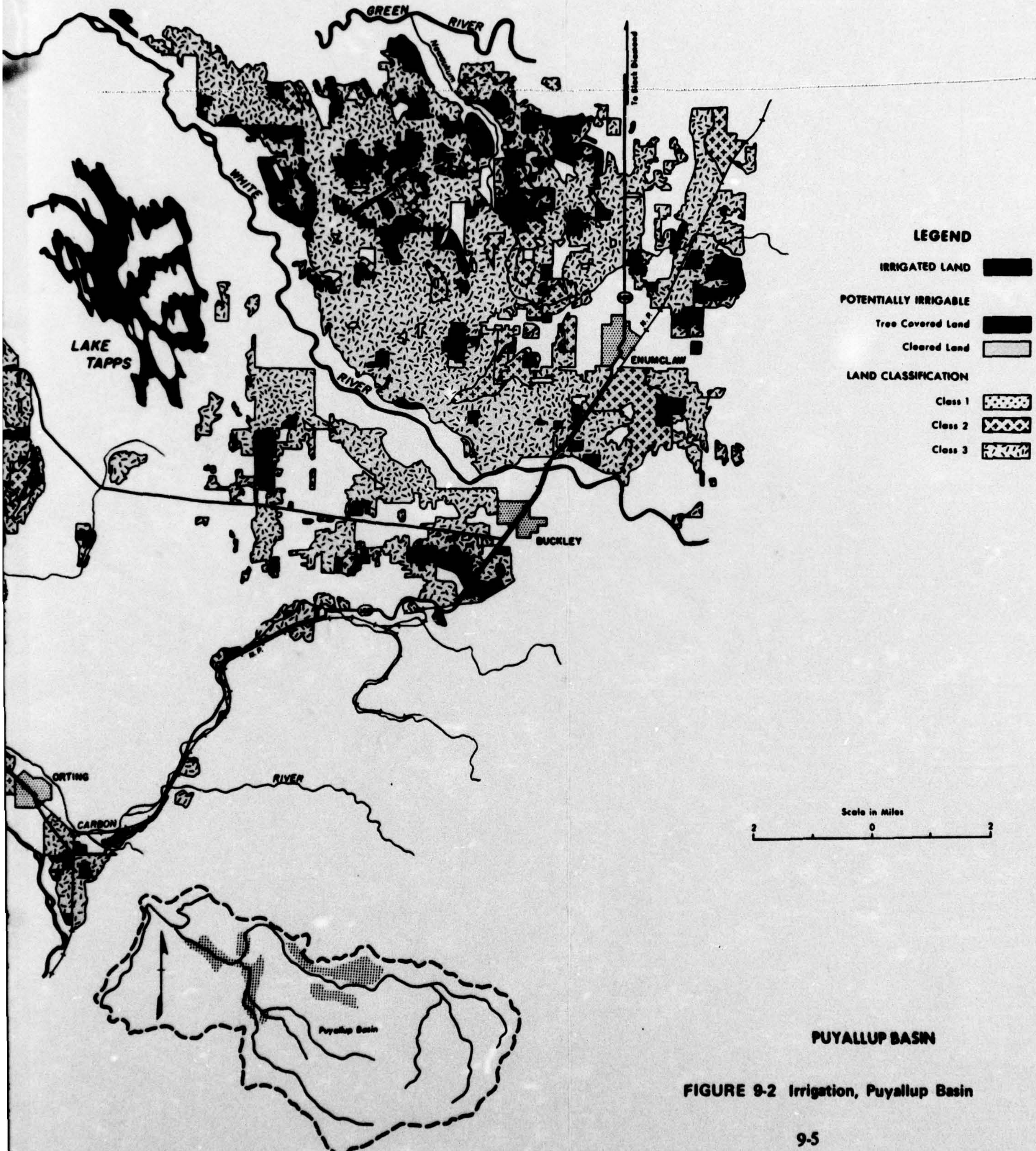
An adequate supply of ground water exists in the lowland portion of the Basin. Most of the irrigation wells are on the flood plains of the Puyallup and White rivers. The largest well yields pump more than 3,000 gallons per minute. Low to moderate yields are found throughout the remainder of the Basin. Lowest yields are found in the higher elevations especially on the upper reaches of the Puyallup River.

Most fresh-water aquifers contain water that is low in dissolved solids. Objectionable concentrations

**TABLE 9-1 Monthly and annual runoff--1,000's of acre-feet (Period 1931-1960)**

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PUYALLUP RIVER NEAR ORTING (172 sq. mi.) | | | | | | | | | | | | | |
| Max(1934) | 63.8 | 62.2 | 185.4 | 142.3 | 35.2 | 48.8 | 38.4 | 32.6 | 18.5 | 33.6 | 32.7 | 19.6 | 713.1 |
| Min (1941) | 28.4 | 32.4 | 35.5 | 27.0 | 15.8 | 16.3 | 22.5 | 30.4 | 30.5 | 34.8 | 32.8 | 30.4 | 336.8 |
| Mean | 32.6 | 48.7 | 59.6 | 49.8 | 39.1 | 38.2 | 39.0 | 48.9 | 52.4 | 44.0 | 31.8 | 25.3 | 509.4 |
| PUYALLUP RIVER AT PUYALLUP (948sq. mi.) | | | | | | | | | | | | | |
| Max (1960) | 411.3 | 523.4 | 406.6 | 242.1 | 305.9 | 239.6 | 290.3 | 375.2 | 366.5 | 247.9 | 194.2 | 161.0 | 3.764.0 |
| Min (1941) | 97.8 | 131.9 | 154.7 | 142.9 | 100.0 | 97.5 | 117.7 | 158.4 | 158.6 | 136.4 | 106.8 | 108.2 | 1,510.9 |
| Mean | 138.9 | 220.9 | 286.5 | 244.5 | 201.9 | 204.4 | 220.4 | 267.9 | 278.2 | 200.4 | 127.1 | 102.9 | 2.494.0 |
| WHITE RIVER NEAR BUCKLEY (401 sq. mi.) | | | | | | | | | | | | | |
| Max (1956) | 90.8 | 186.6 | 182.2 | 99.6 | 44.8 | 74.4 | 168.5 | 218.5 | 212.6 | 147.0 | 63.3 | 38.2 | 1,616.6 |
| Min (1941) | 39.4 | 55.1 | 79.6 | 56.0 | 36.5 | 39.8 | 56.7 | 76.2 | 74.5 | 58.5 | 44.2 | 41.0 | 657.5 |
| Mean | 53.4 | 93.6 | 116.9 | 97.6 | 73.9 | 81.2 | 103.3 | 141.7 | 143.1 | 93.2 | 53.9 | 39.9 | 1,091.7 |


TACOMA
PUYALLUP
PUYALLUP
RIVER
STUCK
RIVER
SUMNER
LAKE
TAPPS
WHITE
SPANAWAY
LAKE
SPANAWAY
ORTING
CARBON




PUYALLUP BASIN

FIGURE 9-2 Irrigation, Puyallup Basin



2

**PHOTO 9-4. Irrigated pasture near Orting. (USBR photo)**

of iron occur locally, principally in aquifers that underlie the Puyallup and White River flood plain.

## Water Rights

There has been no adjudication of the rights claimed before 1917 in the Puyallup Basin. As of April 30, 1966, 349 permits or certificates had been issued for surface water rights for irrigation. The total maximum diversion to serve these rights is about 55 cubic feet per second for about 5,000 acres.

Ground water irrigation rights as of September 30, 1966 total about 57 cubic feet per second for about 3,000 acres.

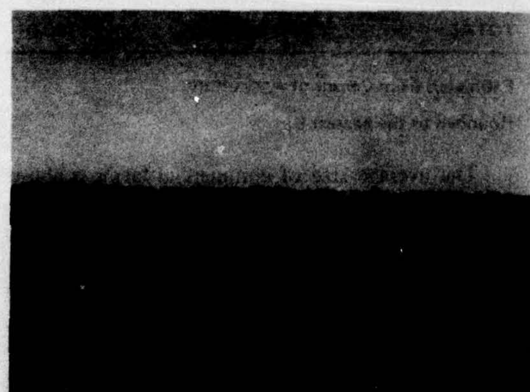


**PHOTO 9-5. Irrigated decorative and cherry tree seedlings west of Puyallup. (USBR photo)**

## Water Requirements

The irrigation requirements were estimated using climatological data for adjacent basins. The average rainfall at the Puyallup Government Station for the months of July and August is less than two inches. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

Annual consumptive use of the irrigated crops is estimated to be 2.24 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops, would be about 0.89 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.35 acre-feet per acre. With an estimated farm irrigation efficiency of 60 percent, a farm delivery requirement of 2.25 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of 5 percent of the diverted amount, the presently irrigated lands (3,720 acres) require an average annual diversion of about 8,800 acre-feet. About 60 percent of this comes from surface sources and 40 percent from ground water.

The monthly irrigation requirements are shown in Table 9-2.

Presently irrigated lands would produce an annual net return flow of 3,100 acre-feet. The resulting depletion of ground and surface water is about 5,700 acre-feet annually.

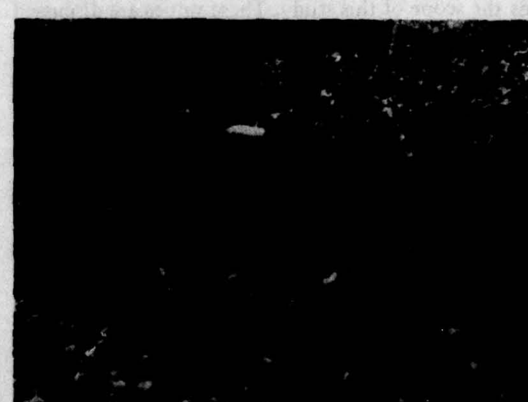


**PHOTO 9-6. Typical irrigation diversion near Sumner. (USBR photo)**

**TABLE 9-2. Irrigation requirements**

| Item | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| Distribution | 4% | 21% | 31% | 30% | 14% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .05 | .28 | .42 | .41 | .19 | 1.35 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .09 | .47 | .70 | .67 | .32 | 2.25 |
| Diversion Requirement (Acre-Feet/Acre) | .09 | .50 | .74 | .71 | .33 | 2.37 |

## Adequacy of Supply

The quantity of the waters in the Puyallup Basin are adequate to meet the present irrigation needs of the area.

# IRRIGATION ECONOMY

## Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average growing season. These incremental values are $338,000 from increased crop production and $155,000 from increased production of livestock and livestock products for a total value of $493,000.

Other values from irrigation accrue to the farmer and to other sectors of the local economy but were not evaluated because the detail involved exceeds the scope of this study. These values are discussed briefly in the section of this appendix covering The Puget Sound Area.

## Basic Data

Agricultural Census data for 1964, and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect Basin boundaries rather than county boundaries. These adjustments are explained in detail in the section of this appendix covering The Puget Sound Area.

## Number, Type, and Size of Farms

There are about 1,575 farms in the Puyallup Basin. About 85 of the farms, or 5 percent had irrigated cropland in 1964. As shown in Table 9-3, farming enterprises identified by source of farm income are about evenly divided between livestock operations and crop farms.

**TABLE 9-3. Farm types—1964**[1]

| Type of Farm | Estimated Number in Basin[2] | Percent of Total |
|---|---|---|
| Field Crops | 5 | .3 |
| Vegetable | 40 | 2.5 |
| Fruit and Nut | 175 | 11.1 |
| Poultry | 105 | 6.7 |
| Dairy | 110 | 7.0 |
| Other Livestock | 100 | 6.3 |
| General | 15 | 1.0 |
| Miscellaneous | 1,025 | 65.1 |
| TOTAL | 1,575 | 100.0 |

[1] Estimated from Census of Agriculture.

[2] Rounded to the nearest 5.

The average size of commercial farms is about 90 acres and farms with irrigated cropland average about 100 acres. Commercial farms with milk cows average about 30 head per farm.

Although only about half of the farming enterprises in the Basin are livestock operations, nearly two-thirds of the irrigated cropland is in forage crops. Slightly more than half of the remaining irrigated cropland is in berry crops. Vegetable crops constitute the remainder.

## Crops

Total crop production related to irrigation use is shown in Table 9-4.

**TABLE 9-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre[1] | Total[2] |
|---|---|---|---|---|
| Forages | 2,450 | | | |
| Hay | (1,030) | Ton | 1.41 | 1,452 |
| Pasture | (1,420) | AUM | 3.37 | 4,785 |
| Vegetables | 590 | Ton | 1.95 | 1,150 |
| Snap Beans | (110) | Ton | (2.26) | (250) |
| Cabbage | (70) | Ton | (4.50) | (320) |
| Cauliflower | (60) | Ton | (1.74) | (100) |
| Celery | (80) | Ton | (2.15) | (170) |
| Sweet Corn | (70) | Ton | (1.79) | (120) |
| Lettuce—Fall | (160) | Ton | (1.15) | (180) |
| Rhubarb | (40) | Ton | (.30) | (10) |
| Berries | 660 | Ton | 1.26 | 830 |
| Strawberries | (190) | Ton | (1.24) | (240) |
| Raspberries | (330) | Ton | (1.40) | (460) |
| Blackberries | (70) | Ton | (1.04) | (70) |
| Blueberries | (70) | Ton | (.92) | (60) |
| TOTAL | 3,700 | | | |

1 See the Puget Sound Area for method of derivation.

2 Rounded to the nearest 10.

Forage crops are grown on about 66 percent of the irrigated cropland. Irrigated forage crops are hay and pasture and these are generally a grass or grass-clover mix.

The early crop of grass, generally cut in May, is harvested for silage or green feed, as the weather is too wet to make hay or to graze. Later in the season most of this same cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basin.

Large population centers and processors in and near the Basin provide market outlets for the irrigated berries produced. Strawberries, raspberries, blueberries and blackberries are the commercially important berries that are irrigated. Except for blueberries most are sold to processors for freezing and canning. Most blueberries are sold for fresh market use.

Snap beans, cabbage, cauliflower, celery, sweet corn, fall lettuce and rhubarb are commercially important vegetables that are irrigated. Processors in and near the Basin take most of the snap beans and cabbage. Celery, lettuce and rhubarb are sold on the fresh market.

The Puyallup Basin is one of the two areas in the State with commercial rhubarb production and one of the few areas in the nation producing rhubarb in hothouses.

Sweet corn and cauliflower are sold to both fresh market outlets and processors. Other vegetables grown commercially generally are not irrigated.

## Crop Values

Crop values related to irrigation are shown in Table 9-5.

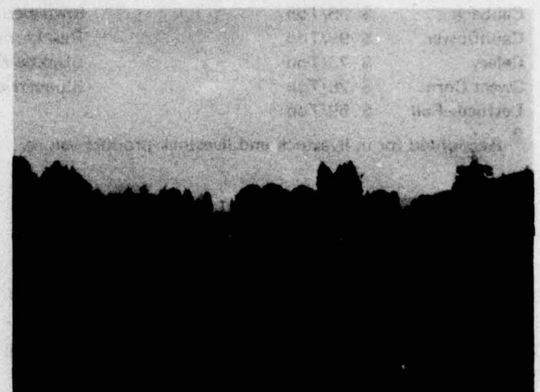


**PHOTO 9-7. Irrigating grass at McMillan near Orting. (USBR photo)**

**PHOTO 9-8. Rhubarb under irrigation near Sumner. (USBR photo)**

**TABLE 9-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value: Per Unit[1] (dollars) | Value: Total (dollars) |
|---|---|---|---|---|
| Forages | | | | |
| Hay | Ton | 1,452 | – | –[2] |
| Pasture | AUM | 4,785 | – | –[2] |
| Vegetables | Ton | 1,150 | 70 | 80,500 |
| Berries | Ton | 830 | 310 | 257,300 |
| Total | | | | 337,800 |
| Rounded | | | | 338,000 |

[1] Weighted average prices received–adjusted normalized basis

| | | | |
|---|---|---|---|
| Snap Beans | $130/Ton | Rhubarb | $ 89/Ton |
| Cabbage | $ 36/Ton | Strawberries | $270/Ton |
| Cauliflower | $ 99/Ton | Raspberries | $330/Ton |
| Celery | $ 73/Ton | Blackberries | $240/Ton |
| Sweet Corn | $ 26/Ton | Blueberries | $390/Ton |
| Lettuce–Fall | $ 59/Ton | | |

[2] Accounted for in livestock and livestock product values.

## Livestock

Cattle operations are the major livestock enterprises in the Basin. The Seattle-Tacoma area provides the market for most livestock products. The derivation of estimated animal units of feed requirements and production is shown in Table 9-6.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 3.7 percent of the total feed required in the Basin. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation, based on total digestible nutrient (TDN) requirements, is shown in Table 9-7. The production is based on 3.7 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 9-6.

In terms of TDN's only, the full feed requirements of about 1,080 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basin raise all of their feed. In reality, the nutritional requirements of many more than 1,080 head of cattle are partially satisfied by irrigated feeds.

**TABLE 9-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow[2] | 1.67[2] | 6,220 | 10,387 |
| Per Feeder | .58 | 4,630 | 2,685 |
| Beef Cattle | | | |
| Per Cow[2] | 1.27[2] | 3,340 | 4,242 |
| Per Feeder | .38 | 4,510 | 1,714 |
| Total | | | 19,028 |
| Rounded | | | 19,000 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grains | | | |
| Hay–Ton | 1,452 | .20 | 290 |
| Pasture–AUM | 4,785 | .08 | 383 |
| Small Grains–Ton | – | – | – |
| Corn Silage–Ton | – | – | – |
| Total | | | 673 |
| Rounded | | | 700 |

[1] Rounded to the nearest 10 head

[2] Includes the normal number of replacement stock and bulls on a per head basis.

[3] Animal Units of feed per ton/AUM.

### Livestock and Livestock Product Values

Livestock and livestock product values related to irrigation are shown in Table 9-8. The value estimates of livestock and livestock products are based on the proportion of feed attributable to irrigation.

**TABLE 9-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Realted to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and calves | 9,820 head | 19,440 head | 29,260 head | 3.7 | 1,080 head |
| Milk | 64,625,900 lbs. | -- | 64,625,900 lbs | 3.7 | 2,391,200 lbs. |
| Butterfat in cream | 17,600 lbs | -- | 17,600 lbs. | 3.7 | 700 lbs. |

[1]Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**Table 9-8 Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 3,044,900 | 1.051 | 3,200,190 | 3.7 | 118,400 |
| Cattle and Calves | 941,000 | 1.051 | 989,411 | 3.7 | 36,600 |
| Total | | | | | 155,000 |
| Rounded | | | | | 155,000 |

[1] Prices received—livestock and livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1964 index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Puyallup Basin total 42,330 acres, of which 3,720 are presently irrigated and 38,610 are potentially irrigable. These lands are found on rolling uplands, relatively smooth intermediate terraces, bottom land areas along the major streams, and scattered peat deposits. It is expected that a total of nearly 14,000 acres will be under irrigation in the Basin by the year 2020.

### Land Characteristics

Soils within the Basin have developed under the influence of high rainfall and moderate temperatures. They are typical of soil development in Western Washington and range from slightly to strongly acid in the surface soil but generally become less acid with depth. The soils are free of accumulation of harmful salts. Textures range from very light loamy sands to heavy clay loams and silty clay loams. A large portion of the soils are underlain by open,

gravelly substrata and would respond well to irrigation. A small part are underlain by cemented glacial till or drift with low permeability; these soils are suited to irrigation, but close control of water would be necessary to prevent over irrigation.

In general, the potentially irrigable lands are well adapted to sprinkler irrigation. Of the cleared lands, only about 3 percent have some degree of topographic deficiency. Of the uncleared or tree covered lands about 27 percent have topographic deficiency characterized by generally rolling topography with slopes over 10 percent but less than 20 percent in general gradient.

About 9,500 acres, or 28 percent of the cleared lands, and about 3,800 acres or 65 percent of the uncleared lands have varying degrees of drainage deficiencies. On the glacial upland soils the deficiency is primarily internal and close control of irrigation water would be necessary to maintain a desirable balance between application and intake to prevent waterlogging. Imperfectly and poorly drained alluvial and terrace lands usually have high water tables and would require extensive drainage works to alleviate the condition. Some of these lands can be improved by construction of shallow surface drains, and improvement of natural channels for removal of heavy winter precipitation.

### Land Classes

Potentially irrigable lands in the Puyallup Basin total 38,610 acres, of which 5,690 are presently in woodlands. The following tabulation shows the acreage distribution of potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 390 | 0 | 390 |
| 2 | 7,780 | 400 | 8,180 |
| 3 | 24,750 | 5,290 | 30,040 |
| TOTAL | 32,920 | 5,690 | 38,610 |

Location of these lands is shown on Figure 9-2.

## PROJECTION OF FUTURE IRRIGATION

The rich agricultural lands in the lower White and Puyallup river basins are intensively irrigated at the present time. In comparison to the Green River Valley, little industrial expansion has penetrated the agricultural areas of the Puyallup. Future land use in the present agricultural areas will be dependent upon flood control protection, resultant flood plain zoning, and the long-range planning and zoning by Pierce County.

It is expected that about 10,000 acres of new lands will eventually be under irrigation. Present and future irrigation water demands are:

| Year | New Irrigation (acres) | Future Supply Source GW (acres) | Future Supply Source SW (acres) | Surface Diversion Annual (ac. ft.) | Surface Diversion Peak (cfs) |
|---|---|---|---|---|---|
| Present | --- | 1,500 | 2,200 | 5,000 | 30 |
| 1980 | 2,500 | 1,000 | 1,500 | 4,000 | 20 |
| 2000 | 5,000 | 1,700 | 3,300 | 8,000 | 50 |
| 2020 | 2,500 | 800 | 1,700 | 4,000 | 25 |

Maximum irrigation requirements for the area are as follows:

| | |
|---|---|
| **Peak farm delivery requirement** | **69 acre/cfs** |
| **Farm delivery requirement** | **2.25 acre-feet/acre** |
| **Diversion requirement** | **2.37 acre-feet/acre** |

The monthly distribution of the irrigation requirement is shown below as percent of annual demand.

| | |
|---|---|
| May | 4% |
| June | 21% |
| July | 31% |
| August | 30% |
| September | 14% |
| Total | 100% |

## MEANS TO SATISFY NEEDS

Future water requirements for those lands projected to be irrigated will probably be from both surface and ground water. Future development is expected to be by private means. The lands receiving their supplies from the Puyallup River will probably be individual systems pumping directly from the Puyallup River into the farm distribution systems. Streamflow records indicate that there is adequate water in the river to meet the future irrigation needs of the Basin. However, when other needs of the Basin are considered, storage may be required to meet these needs. The projected investment costs for the Puyallup Basin is shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $340,000 | -- |
| 1980-2000 | $680,000 | -- |
| 2000-2020 | $340,000 | -- |

If upstream storage is required to meet the water supply needs, additional costs would be involved.

For the 1980 level of development the annual operating costs are estimated to be $11 per acre or $27,500. The operating costs include power, operation, maintenance, and replacement costs. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $133 per acre and are summarized as follows:

| Year | New Irrigation (acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | 2,500 | $332,000 |
| 2000 | 5,000 | 665,000 |
| 2020 | 2,500 | 332,000 |

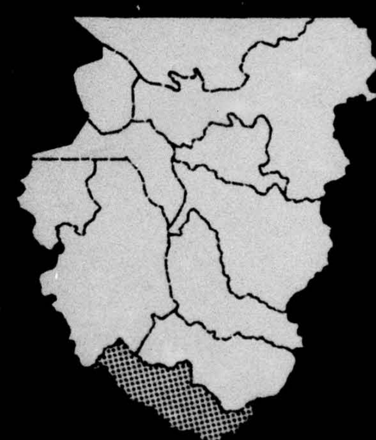
The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system, are discussed in The Puget Sound Area under Means to Satisfy Needs.

Net depletions of surface and ground water sources in the Basin are shown below.

| Year | New Irrig. (acres) | Net Depletion[1] GW (ac. ft.) | Net Depletion[1] SW (ac. ft.) | Total Accumulated Depletion (ac. ft) |
|---|---|---|---|---|
| Present | --- | 2,300 | 3,400 | 5,700 |
| 1980 | 2,500 | 1,600 | 2,300 | 9,600 |
| 2000 | 5,000 | 2,600 | 5,100 | 17,300 |
| 2020 | 2,500 | 1,200 | 2,600 | 21,100 |

1 Diversion requirement minus return flow.

# Nisqually-Deschutes Basins



# NISQUALLY-DESCHUTES BASINS

The Nisqually-Deschutes Basins lie southeast of the southern end of Puget Sound and contain parts of Pierce, Thurston and Lewis counties. The Nisqually River originates from the glaciers on the southwestern slopes of Mt. Rainier. It flows through steep mountainous valleys and La Grande Canyon, a deep narrow gorge, and finally emerges on a benchland of glacial moraines. On this benchland it is joined by a number of small tributary streams and flows 41 miles, finally discharging into Puget Sound at the Nisqually Flats, midway between Tacoma and Olympia.

The Deschutes River originates in the hills southeast of Yelm and flows across the same benchland of glacial moraines to enter Puget Sound at Budd Inlet, the harbor for the city of Olympia.

The climate of the Basins is characterized by cool summers and wet, mild winters. The average annual precipitation ranges from about 40 inches at the Puget Sound to over 120 inches on Mt. Rainier. Precipitation is low in the months of July, August and September in the lower regions.

The upper areas of the Basins are covered by dense forests of Douglas fir, western hemlock and western red cedar. Forested areas are controlled by the National Park Service, the U.S. Forest Service, State of Washington Department of Natural Resources and private timber companies. Portions of the lower benchlands have been cleared for urban build-up, the Fort Lewis Military Reservation, and for agricultural purposes. Land use near the Puget Sound is mostly intense residential and industrial. Land use in the Basins is shown below:

| | Acres |
|---|---|
| Cropland | 45,000 |
| Rangeland | 43,000 |
| Forest | 508,000 |
| Rural nonagricultural | 20,000 |
| Built-up areas | 19,000 |
| Total | 635,000 |

The economy of the Basins is based primarily on lumbering and production of forest products. Boat building, can manufacturing, cold storage and meat

**PHOTO 10-1. Weir Prairie northwest of Rainier. Deschutes River in foreground. (USBR photo)**

packing industries provide a diversified commercial base for the Basins. The Port of Olympia is equipped to handle cargo from both ocean vessels and local water freight. Livestock raising is the most common agricultural enterprise. Agricultural areas are intensively farmed to produce high value products. Government is the leading employer in the Basins.

The population of the Basins was 70,100 in 1967. Olympia, the State capitol, had a population of 20,880. Tumwater and Eatonville had populations of 4,698 and 900, respectively. Smaller communities, the Fort Lewis Military Reservation and rural population account for the balance of the 1963 population.

PHOTO 10-2. Irrigated pasture near Yelm. (USBR photo)

## PRESENT STATUS

Irrigation development is located throughout the lower elevations of the Basins. The largest concentrations are found south of Olympia and in the vicinity of Yelm. Irrigated lands are generally located in areas with easily available water supplies. In 1966, about 5,600 acres were irrigated in the Basins, and this is considered to be the normally irrigated acreage. Figure 10-1 shows the relationship between crop consumptive use, effective precipitation and crop irrigation requirements for the Basins.

### IRRIGATED LANDS

Soils of the benchlands are derived from glacial drift and lake deposits. These soils are sandy or gravelly loams and are generally well drained. They are excessively drained where they overlie loose, sandy or gravelly glacial drift. The soils on flood plains are formed from coarse-textured alluvial materials and are well drained. Most of the presently irrigated lands are nearly level. About 10 to 15 percent of the lands are gently sloping with gradients usually less than 5 percent.

Except for a block of land irrigated near Yelm in the Smith Prairie area, the irrigated lands are generally located in relatively small patches throughout the Basins.

In the Deschutes Basin, the irrigated lands are generally those with light textured sandy soils or gravelly soils with shallow to open gravel understrata.

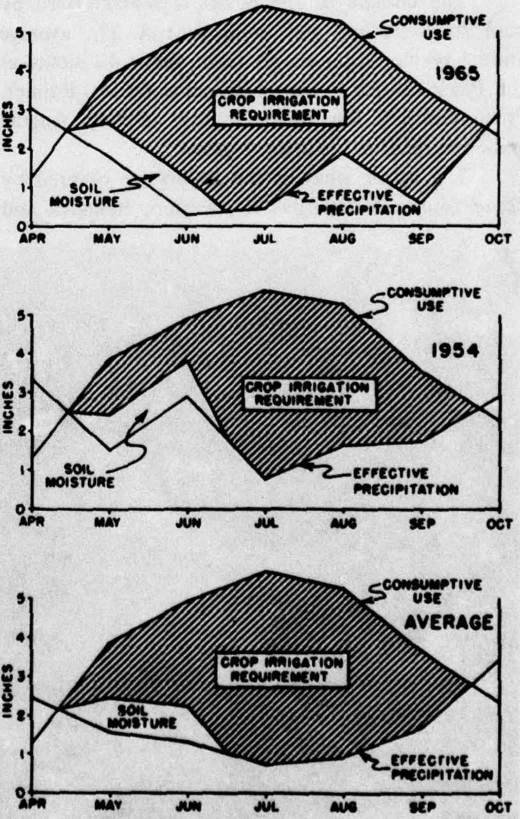



FIGURE 10-1. Crop irrigation requirements for typical dry, wet, and average years.

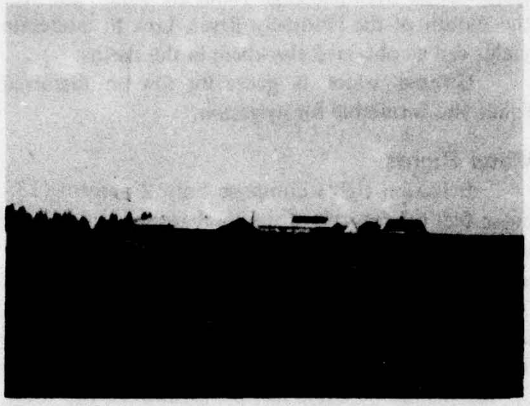


PHOTO 10-3. Typical of irrigated lands in the Basins is this pasture near McKenna. (USBR photo)

Presently irrigated lands in the Nisqually-Deschutes Basins were classified as classes 1, 2, or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 10-2. A summary of the lands irrigated in 1966 follows:

| Land Class | Irrigated (Acres) |
|---|---|
| 1 | 350 |
| 2 | 2,240 |
| 3 | 2,990 |
| Total | 5,580 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Water supply for the irrigated lands is obtained from wells and individual diversions from the Nisqually and Deschutes rivers and their tributaries. About 40 percent of the irrigated lands receive their water supply from ground water and 60 percent from surface sources.

PHOTO 10-4. Smith Prairie north of Lake Lawrence. (USBR photo)

The Nisqually-Deschutes Basins have a relatively large surface water resource. The annual runoff of the Nisqually River near McKenna averages 1,272,000 acre-feet. The Deschutes River has a considerably smaller annual runoff, averaging 285,000 acre-feet near Olympia. Average monthly and annual runoff at selected sites on the Nisqually and Deschutes rivers is shown in Table 10-1.

The highest runoff of the Nisqually River occurs in December with another high runoff period in late spring. The low flow period occurs in August and September, but glacial melt from the slopes of Mt. Rainier makes a significant contribution to summer flows.

The mean monthly discharges for the Deschutes River display a pattern similar to other primarily rain-fed streams with a period of high flow during the winter season, and minimum flows during August and September.

Surface water is of excellent quality for irrigation use based on the analysis of samples taken. Most sediment problems are associated with high river flows. Therefore, the sediment concentration in the rivers would be small during the irrigation season and would present no serious problems associated with irrigation use.

An abundant supply of ground water exists throughout most of the Basins. Ground water is used mostly for irrigation, principally in the Yelm area and southeast of Olympia. High yields are obtainable near the mouth of the Nisqually River. Low to moderate yields can be obtained elsewhere in the Basins.

Ground water is generally low in dissolved solids and is suitable for irrigation.

### Water Rights

Irrigation rights comprise only 2 percent (135 cubic feet per second) of the total ground and surface water rights in the Basins. There has been no adjudication involving vested water rights. As of April 30, 1967, there were 7,000 acres which had an application, a permit or a certificate for a water right. The total maximum diversion to serve this acreage is approximately 68 cubic feet per second. Of this total, 36 cubic feet per second is for 3,600 acres in the Deschutes drainage, while 32 cubic feet per second is for 3,400 acres in the Nisqually drainage.

Irrigation ground water rights as of September 30, 1966, totaled about 67 cubic feet per second for 4,700 acres.

### Water Requirements

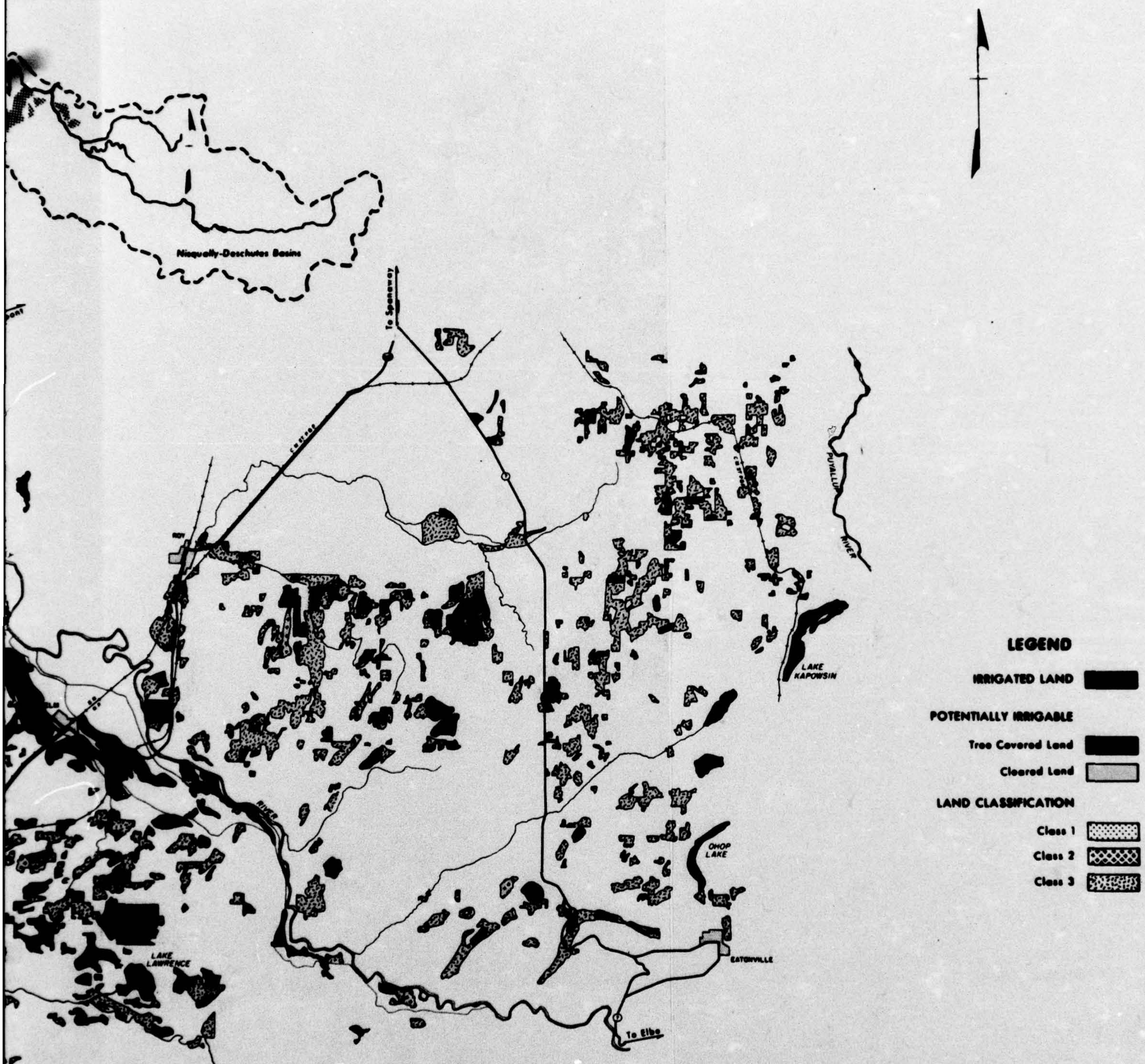
The irrigation requirements for the Deschutes-Nisqually Basins have been estimated using climatological data from the Olympia Weather Bureau Station. Less than one inch of rain falls during either July or August at Olympia. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria

**TABLE 10-1. Monthly and annual runoff—1,000's of acre-feet (period: 1931-1960)**

| | Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | DESCHUTES RIVER near RAINIER: (89.8 sq. mi.) | | | | | | | | |
| Max.* | (1956) | 16.9 | 42.8 | 65.4 | 48.2 | 17.4 | 45.2 | 21.8 | 8.0 | 7.0 | 3.3 | 2.6 | 2.1 | 280.7 |
| Min.* | (1941) | 4.5 | 9.5 | 13.7 | 19.2 | 8.6 | 8.2 | 7.2 | 10.0 | 5.2 | 2.9 | 2.3 | 4.7 | 96.1 |
| Mean | | 6.6 | 19.8 | 32.1 | 31.5 | 27.9 | 24.9 | 17.5 | 10.0 | 6.4 | 3.5 | 2.5 | 2.6 | 185.3 |
| | | | | | | DESCHUTES RIVER near OLYMPIA: (160 sq. mi.) | | | | | | | | |
| Max.* | (1956) | 21.6 | 55.1 | 83.5 | 64.1 | 29.4 | 70.7 | 33.8 | 15.4 | 13.1 | 8.4 | 7.0 | 6.0 | 408.1 |
| Min.* | (1941) | 8.5 | 13.4 | 22.6 | 31.2 | 17.7 | 14.7 | 13.3 | 17.8 | 11.3 | 7.9 | 6.6 | 8.6 | 173.6 |
| Mean | | 10.5 | 25.7 | 43.8 | 44.9 | 41.9 | 39.5 | 27.5 | 17.7 | 12.3 | 8.4 | 6.7 | 6.4 | 285.3 |
| | | | | | | NISQUALLY RIVER at LaGRANDE: (292 sq. mi.) | | | | | | | | |
| Max. | (1956) | 112.6 | 236.0 | 243.7 | 166.0 | 97.4 | 104.7 | 120.5 | 146.5 | 119.0 | 83.6 | 50.9 | 53.8 | 1,526.7 |
| Min.* | (1941) | 30.6 | 51.8 | 79.0 | 87.9 | 44.8 | 42.2 | 44.8 | 63.8 | 41.8 | 36.9 | 27.0 | 38.1 | 588.7 |
| Mean | | 61.6 | 98.7 | 138.3 | 122.4 | 97.0 | 100.9 | 94.1 | 100.4 | 82.0 | 57.1 | 42.0 | 41.2 | 1,036.7 |
| | | | | | | NISQUALLY RIVER near McKENNA: (445 sq. mi.) | | | | | | | | |
| Max. | (1956) | 137.6 | 272.9 | 303.6 | 196.6 | 122.4 | 160.1 | 155.9 | 157.6 | 134.9 | 88.6 | 54.5 | 59.9 | 1,843.6 |
| Min. | (1944) | 36.5 | 46.3 | 106.2 | 98.5 | 83.5 | 65.8 | 79.8 | 80.1 | 59.7 | 38.1 | 26.3 | 31.0 | 751.8 |
| Mean | | 72.5 | 123.1 | 177.4 | 164.8 | 127.4 | 132.0 | 123.1 | 120.2 | 94.5 | 60.0 | 42.8 | 44.4 | 1,272.2 |

*From correlation.

Nisqually-Deschutes Basins
To Dupont
To Shelton
OLYMPIA
BLACK LAKE
TUMWATER
PATTERSON LAKE
NISQUALLY
ROY
DESCHUTES
RIVER
To Tenino
RIVER
LAKE LAWRENCE
2
0




NISQUALLY-DESCHUTES BASINS

FIGURE 10-2 Irrigation, Nisqually-Deschutes Basins



Scale in Miles
2 0 2

2

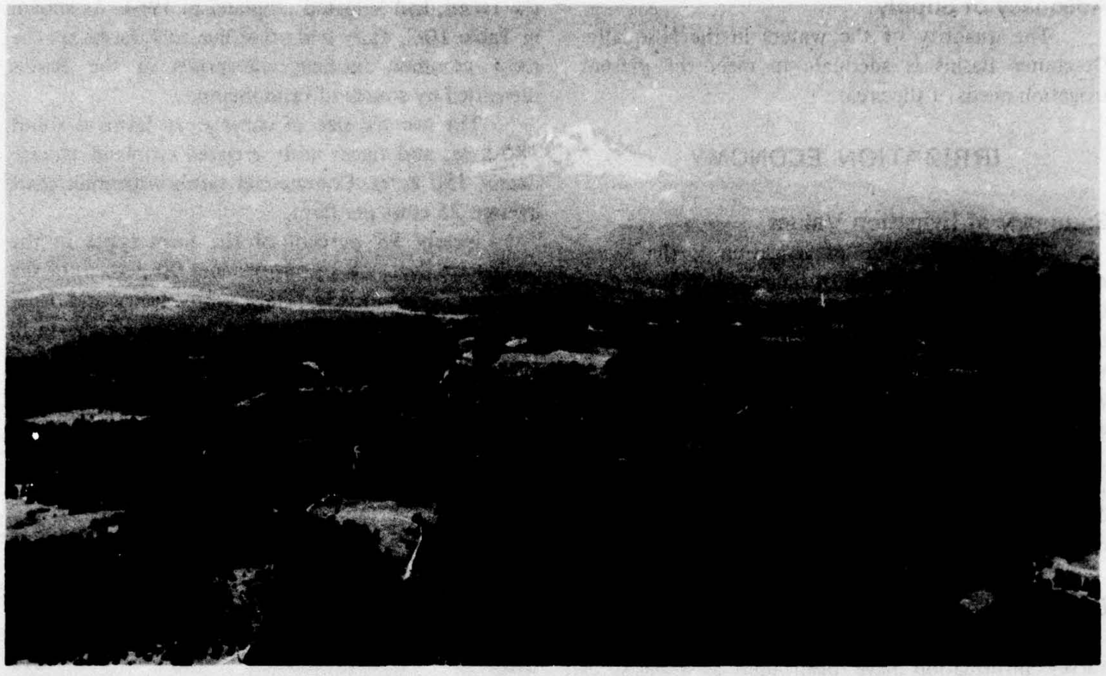


PHOTO 10-5. Upper reaches of Deschutes Basin in foreground. Alder Lake at right center. (USBR photo)

used in developing the water requirements.

The annual consumptive use of irrigated crops is estimated at 2.24 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.89 acre-feet per acre in a dry year. Therefore, the consumptive use to be met by irrigation would be about 1.35 acre-feet per acre. With an estimated farm irrigation efficiency of 60 percent, a farm delivery requirement of 2.25 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of 5 percent of the diverted amount, the presently irrigated lands (5,600 acres) require an average annual diversion of about 13,300 acre-feet. Approximately 40 percent of this would be from ground water and 60 percent from surface water. The monthly irrigation requirements are shown in Table 10-2.

The irrigated lands would produce an annual net return flow of 4,600 acre-feet. Of this total, 2,400 acre-feet would be from the Nisqually drainage and 2,200 acre-feet from the Deschutes drainage. The depletion of ground and surface waters would be 8,700 acre-feet annually; 4,500 in the Nisqually drainage and 4,200 in the Deschutes drainage.

**TABLE 10-2. Irrigation requirements**

| Item | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| Distribution | 4% | 21% | 31% | 30% | 14% | 100% |
| Crop Irrigation Requirement (Acre-Feet/Acre) | .06 | .29 | .41 | .40 | .20 | 1.35 |
| Farm Delivery Requirement (Acre-Feet/Acre) | .09 | .48 | .69 | .67 | .32 | 2.25 |
| Diversion Requirement (Acre-Feet/Acre) | .10 | .50 | .73 | .71 | .33 | 2.37 |

### Adequacy of Supply

The quantity of the waters in the Nisqually-Deschutes Basins is adequate to meet the present irrigation needs of the area.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $148,000 from increased crop production and $302,000 from increased production of livestock and livestock products for a total value of $450,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964, and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect Basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 1,190 farms in the Nisqually-Deschutes Basins. More than 15 percent, or 180 of the farms, had irrigated cropland in 1964. As shown in Table 10-3, dairy and other livestock farms are the most common farming enterprises in the Basins identified by source of farm income.

PHOTO 10-6. Woodlands near McKenna are being cleared for agriculture. (USBR photo)

The average size of commercial farms is about 180 acres and farms with irrigated cropland average nearly 150 acres. Commercial farms with milk cows average 25 cows per farm.

Nearly 95 percent of the farm types in the Basins are livestock operations and 90 percent of the irrigated cropland is in forage crops. Dairy and other livestock farms are the most numerous of the farm types with irrigated cropland in the Basins.

TABLE 10-3. Farm Types—1964[1]

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crop | 0 | 0.0 |
| Vegetable | 5 | .4 |
| Fruit and Nut | 15 | 1.3 |
| Poultry | 55 | 4.6 |
| Dairy | 140 | 11.8 |
| Other Livestock | 150 | 12.6 |
| General | 15 | 1.3 |
| Miscellaneous | 810 | 68.0 |
| Total | 1,190 | 100.0 |

1 Estimated from Census of Agriculture.

2 Rounded to the nearest 5.

### Crops

Total crop production related to irrigation use is shown in Table 10-4.

Irrigated forage crops are hay and pasture and these are generally a grass or grass-clover mix. The early crop of grass, generally cut in May, is harvested for silage or green feed, because the weather is too wet to make hay or to graze. Later in the season most of this same cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basins.

Sweet corn, and snap beans are the commercially important vegetable crops in the Basins. Both are irrigated. The major portion of the commerical vegetables produced are marketed to processors for canning and freezing.

Strawberries, raspberries and blueberries are commercially grown berries that are irrigated. Other

**TABLE 10-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit or Yield | Increased Production Related to Irrigation Per Acre[1] | Total[2] |
|---|---|---|---|---|
| Forages | 4,990 | | | |
| Hay | (2,150) | Ton | 1.75 | 3,760 |
| Pasture | (2,840) | AUM | 4.17 | 11,840 |
| Vegetables | 390 | Ton | 1.67 | 650 |
| Snap Beans | (60) | Ton | (2.50) | (150) |
| Sweet Corn | (330) | Ton | (1.52) | (500) |
| Berries | 220 | Ton | 1.55 | 340 |
| Strawberries | (120) | Ton | (1.00) | (120) |
| Blueberries | (60) | Ton | (3.00) | (180) |
| Raspberries | (30) | Ton | (1.00) | (30) |
| Blackberries | (10) | Ton | (1.00) | (10) |
| Total | 5,600 | | | |

1 See The Puget Sound Area for method of derivation.

2 Rounded to the nearest 10.

**TABLE 10-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value Per Unit* (Dollars) | Value Total (Dollars) |
|---|---|---|---|---|
| Forages | | | | |
| Hay | Ton | 3,760 | | ** |
| Pasture | AUM | 11,840 | | ** |
| Vegetables | Ton | 650 | 50 | 32,500 |
| Berries | Ton | 340 | 340 | 115,600 |
| Total | | | | 148,100 |
| Rounded | | | | 148,000 |

*Weighted average prices received—adjusted normalized basis

| | | | |
|---|---|---|---|
| Snap Beans | $130/Ton | Strawberries | $270/Ton |
| Sweet Corn | $ 26/Ton | Raspberries | $330/Ton |
| | | Blueberries | $390/Ton |
| | | Blackberries | $240/Ton |

**Accounted for in livestock and livestock product values.

berries grown commercially generally are not irrigated. Most strawberries and raspberries are sold to processors for freezing. Blueberries are mostly sold on the fresh market.

## Crop Values

Crop values related to irrigation are shown in Table 10-5.

## Livestock

Cattle operations are the major livestock enterprise in the Basins. Meat packing plants are located in the Basins and in nearby towns. Dairy processing plants are located in Seattle. The derivation of estimated animal units of feed requirements and production is shown in Table 10-6.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 6.5 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (TDN) requirements, is shown in Table 10-7. The production is based on 6.5 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 10-6.

In terms of T.D.N.'s only, the full feed requirements of about 3,200 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all of their feed. In reality, the nutritional requirements of many more than 3,200 head of cattle are partially satisfied by irrigated feeds.

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 10-8. The value estimates of livestock and livestock products are based on the proportion of feed attributable to irrigation.

**TABLE 10-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 7,110 | 11,874 |
| Per Feeder | .58 | 7,270 | 4,217 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 6,320 | 8,026 |
| Per Feeder | .38 | 5,610 | 2,132 |
| Total | | | 26,249 |
| Rounded | | | 26,200 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages and Grains | | | |
| Hay–Ton | 3,760 | .20 | 752 |
| Pasture–AUM | 11,840 | .08 | 947 |
| Small Grains–Ton | | | |
| Corn Silage–Ton | | | |
| Total | | | 1,699 |
| Rounded | | | 1,700 |

1 *Rounded to the nearest 10 head.*

2 Includes feed required for replacements, bulls and young stock usually associated with the breeding herd.

3 Animal Units of feed per ton/AUM.

**TABLE 10-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 20,900 head | 28,460 head | 49,360 head | 6.5 | 3,200 head |
| Milk | 69,119,200 lbs. | | 69,119,200 lbs. | 6.5 | 4,525,200 lbs. |
| Butterfat in cream | 19,400 lbs. | | 19,400 lbs. | 6.5 | 1,300 lbs. |

1 Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 10-8. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (Dollars) | Adjustment Factor[1] | Adjusted Value of Sales (Dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (Dollars) |
|---|---|---|---|---|---|
| Dairy Products | 3,185,400 | 1.051 | 3,351,008 | 6.5 | 217,800 |
| Cattle and Calves | 1,234,700 | 1.051 | 1,297,670 | 6.5 | 84,300 |
| Total | | | | | 302,100 |
| Rounded | | | | | 302,000 |

[1] Prices received—Livestock and Livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1964 Index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Nisqually-Deschutes Basins total 48,850 acres, of which 5,580 are presently irrigated and 43,270 are potentially irrigable. The lands are located on gravelly terraces and rolling glacial uplands. A total of nearly 21,000 acres are expected to be under irrigation in the Basins by the year 2020.

### Land Characteristics

Soils within the Nisqually-Deschutes Basins have been developed under the influence of high rainfall and moderate temperatures. They are slightly to moderately acid in the surface soil and become less acid with depth, and are free from accumulations of soluble salts. Soils have developed on upland glacial drift and on terraces from glacial outwash materials. The soils of the outwash plains normally are gravelly, sandy and porous with open understrata. The glacial uplands generally have gravelly or sandy porous soils underlain by cemented slowly permeable drift but in some places the understrata is open gravelly material.

Most of the potentially irrigable lands are well adapted to sprinkler irrigation. The gravelly outwash plains are smooth and slightly sloping. The glacial uplands are generally undulating to rolling, but the steepness of the predominant slope is well within the limits established in the land classification specifications.

About 11,000 acres of the potentially irrigable lands in the Nisqually Basin and about 5,000 acres in the Deschutes Basin have varying degrees of drainage problems. On the glacial upland soils the deficiency is primarily subsoils with slow permeability and close control of water application would be necessary to prevent overirrigation. Sprinkler application would be the practicable method on these lands.

### Land Classes

Potentially irrigable lands in the Nisqually Basin total 23,500 acres, of which 5,330 are presently in woodlands. The following tabulation shows the acreage distribution of the potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (Acres) | Potentially Irrigable in Tree Cover (Acres) | Total (Acres) |
|---|---|---|---|
| 1 | 20 | | 20 |
| 2 | 1,140 | 410 | 1,550 |
| 3 | 17,010 | 4,920 | 21,930 |
| Total | 18,170 | 5,330 | 23,500 |

These lands are shown on Figure 10-2.

Potentially irrigable lands in the Deschutes Basin total 19,770 acres, of which 8,970 are presently

in woodlands. The following tabulation shows the acreage distribution of these potentially irrigable lands by land classes.

| Land Class | Potentially Irrigable Cleared (Acres) | Potentially Irrigable in Tree Cover (Acres) | Total (Acres) |
|---|---|---|---|
| 1 | 1,640 | 850 | 2,490 |
| 2 | 4,790 | 4,160 | 8,950 |
| 3 | 4,370 | 3,960 | 8,330 |
| Total | 10,800 | 8,970 | 19,770 |

These lands are shown on Figure 10-2.

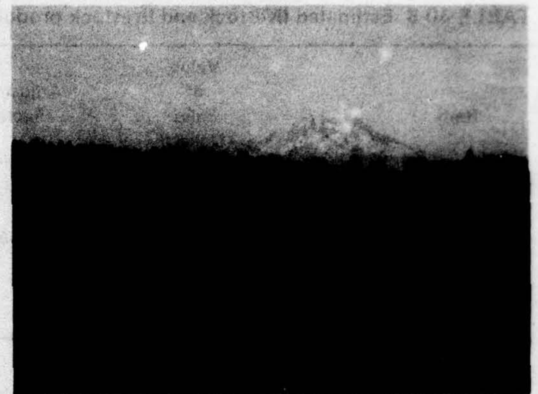


PHOTO 10-7. Potentially irrigable lands on gently rolling uplands near Kapowsin. (USBR photo)

## PROJECTION OF FUTURE IRRIGATION

Projections are that about 14,600 acres of new lands in the Nisqually Basin and 600 acres in the Deschutes Basin will be under irrigation by the year 2020.

Present and future water demands for the Nisqually Basin are:

| Year | New Irrig. (Acres) | Supply Source GW (Acres) | Supply Source SW (Acres) | Surface Diversions Annual (ac. ft.) | Surface Diversions Peak (cfs) |
|---|---|---|---|---|---|
| Present | | 1,100 | 1,800 | 4,300 | 27 |
| 1980 | 1,600 | 1,400 | 200 | 500 | 3 |
| 2000 | 5,000 | 4,000 | 1,000 | 2,400 | 15 |
| 2020 | 8,000 | 6,300 | 1,700 | 4,000 | 25 |

Present and future water demands for the Deschutes Basin are:

| Year | New Irrig. (Acres) | Supply Source GW (Acres) | Supply Source SW (Acres) | Surface Diversions Annual (ac. ft.) | Surface Diversions Peak (cfs) |
|---|---|---|---|---|---|
| Present | -- | 1,100 | 1,600 | 3,800 | 24 |
| 1980 | 600 | 600 | -- | -- | -- |
| 2000 | -- | -- | -- | -- | -- |
| 2020 | -- | -- | -- | -- | -- |

Typical irrigation requirements for the Nisqually-Deschutes Basins are as follows:

| | |
|---|---|
| Peak farm delivery requirement | 68.0 acre/cfs |
| Farm delivery requirement | 2.25 acre-feet/acre |
| Diversion requirement | 2.37 acre-feet/acre |

The monthly distribution of the irrigation requirement is shown as percent of annual demand.

| | |
|---|---|
| May | 4% |
| June | 21% |
| July | 31% |
| August | 30% |
| September | 14% |
| Total | 100% |

# MEANS TO SATISFY NEEDS

There is a potential for project-type development of 5,000 to 7,000 acres on Smith Prairie, south and east of Yelm. Water could be pumped to this area from the Nisqually River through a project distribution system. Streamflow records indicate that there is adequate water in the river to meet the future irrigation needs of the Basins. However, when other needs are considered, storage may be required to meet all requirements. It is expected that future irrigation development will be scattered and will be mostly by private means. The projected investment costs for the Nisqually-Deschutes Basins are shown in the following tabulation:

| Nisqually | Private | Federal |
|---|---|---|
| Present-1980 | $ 218,000 | -- |
| 1980-2000 | $ 680,000 | -- |
| 2000-2020 | $1,080,000 | -- |
| **Deschutes** | | |
| Present-1980 | $ 82,000 | -- |
| 1980-2000 | -- | -- |
| 2000-2020 | -- | -- |

If upstream storage is required to meet the water supply needs, additional costs would be involved. For the 1980 level of development, the annual operating costs are estimated to be $19,000 for the Nisqually Basin and $6,000 for the Deschutes Basin. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $80 per acre and are summarized as follows:

| Year | New Irrigation (Acres) | Farmers Increased Annual Gross Income |
|---|---|---|
| 1980 | | |
| Nisqually | 1,600 | $128,000 |
| Deschutes | 600 | 48,000 |
| 2000 | | |
| Nisqually | 5,000 | 400,000 |
| Deschutes | | |
| 2020 | | |
| Nisqually | 8,000 | 640,000 |
| Deschutes | | |

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

Net depletions of surface and ground water sources in the Basins are shown below.

Nisqually Basin

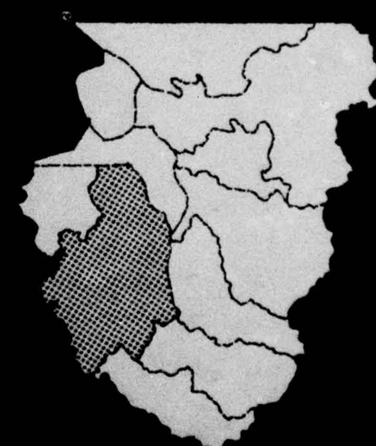
| Year | New Irrig. (acres) | Net Depletion[1] GW (ac.ft.) | SW (ac.ft.) | Total Accumulated Depletion (ac.ft.) |
|---|---|---|---|---|
| Present | | 1,700 | 2,800 | 4,500 |
| 1980 | 1,600 | 2,200 | 300 | 7,000 |
| 2000 | 5,000 | 6,200 | 1,500 | 14,700 |
| 2020 | 8,000 | 9,800 | 2,600 | 27,100 |

Deschutes Basin

| Year | New Irrig. (acres) | Net Depletion GW (ac.ft.) | SW (ac.ft.) | Total Accumulated Depletion (ac.ft.) |
|---|---|---|---|---|
| Present | | 1,700 | 2,500 | 4,200 |
| 1980 | 600 | 900 | | 5,100 |
| 2000 | | | | 5,100 |
| 2020 | | | | 5,100 |

[1] Diversion requirement minus return flow.

# West Sound Basins



# WEST SOUND BASINS

The West Sound Basins include all of Kitsap County and portions of Mason, Jefferson and Clallam counties. The Basins cover an area of 2,620 square miles including 2,022 square miles of land and inland water. The Basins are bounded on the east by the main channel of Puget Sound and on the west by the Olympic Mountains. Hood Canal, which extends 68 miles along the foothills of the Olympic Mountains with a fairly uniform width of 1½ to 2 miles, separates the Basins into two distinct areas, the Olympic and Kitsap Peninsulas. In addition, the Basins contain numerous islands, channels, inlets, passages, and bays of the lower Puget Sound. The larger islands are Vashon, Bainbridge, Maury, Fox, McNeil, Anderson, and Hartstene. Principal rivers draining the east slope of the Olympic Peninsula are the Skokomish, Hamma Hamma, Duckabush, Dosewallips, Big Quilcene, and Little Quilcene. All of these rivers head in the extremely rugged forested areas of the Olympic National Park and Forest, and flow into Hood Canal. Only the Skokomish River passes through a broad flood plain before emptying into Hood Canal.

Because of its highly irregular configuration, the kitsap Peninsula is drained by hundreds of small stream systems. Due to the small size of these drainages and their location in the rain shadow of the Olympic Mountains, stream flows are small in comparison to those on the Olympic Peninsula. All streams on the Kitsap Peninsula originate in and flow through the glacial outwash plains that are characteristic of the Puget Sound lowlands.

The climate of the Basins is influenced by moist marine air from the Pacific Ocean. This moisture is precipitated in the Olympic Mountains causing over 200 inches of rainfall and permanent snowfields at higher elevations. The areas easterly and northeasterly from the Olympic Mountains are partially protected from the prevailing winds and the precipitation is greatly reduced. At Port Townsend, the annual precipitation is less than 20 inches.

The population of the Basins is centered in ports developed around the lumbering industry and around the Puget Sound Navy Yard at Bremerton. Population of the principal cities in 1967 was: Bremerton, 36,170; Shelton, 6,250; and Port Townsend, 5,430.

Agricultural lands, with the exception of timber land, are scattered and in small tracts. Woodland use predominates in the Basins with about 92 percent of

PHOTO 11-1. The lower Skokomish River Valley. (USBR photo)

the total area in forest lands much of which is in Federal ownership in Olympic National Park and the Olympic National Forest.

Land use within the Basins is:

| | Acres |
|---|---|
| Cropland | 46,000 |
| Rangeland | 5,000 |
| Forest | 1,124,000 |
| Rural-nonagricultural | 64,000 |
| Built-up areas | 42,000 |
| TOTAL | 1,281,000 |

Transportation facilities are limited. The Northern Pacific Railroad operates a line from Olympia to Shelton, Bremerton, and Bangor.

# PRESENT STATUS

Irrigation use in the West Sound Basins is located in two areas. About half of the lands presently irrigated are located in the Chimacum Valley south of Port Townsend. The rest are located in the Skokomish River Valley north of Shelton. In 1966, there were about 1,200 acres irrigated in the Basins. This is considered to be the normally irrigated acreage in the Basins. Figure 11-1 illustrates the relationship between crop consumptive use, effective precipitation and crop irrigation requirements.

## IRRIGATED LANDS

Soil textures of the irrigated lands range from medium to fine, and their topography is generally smooth. The lands are generally located in small scattered patches along the river bottom lands and on the fan-shaped outwash plains of the major streams.

Presently irrigated lands in the Basins were classified as Classes 1, 2 or 3, depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 11-2. A summary of the lands irrigated in 1966 is shown below.

| Land Class | Irrigated (acres) |
|---|---|
| 1 | 410 |
| 2 | 90 |
| 3 | 700 |
| TOTAL | 1,200 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

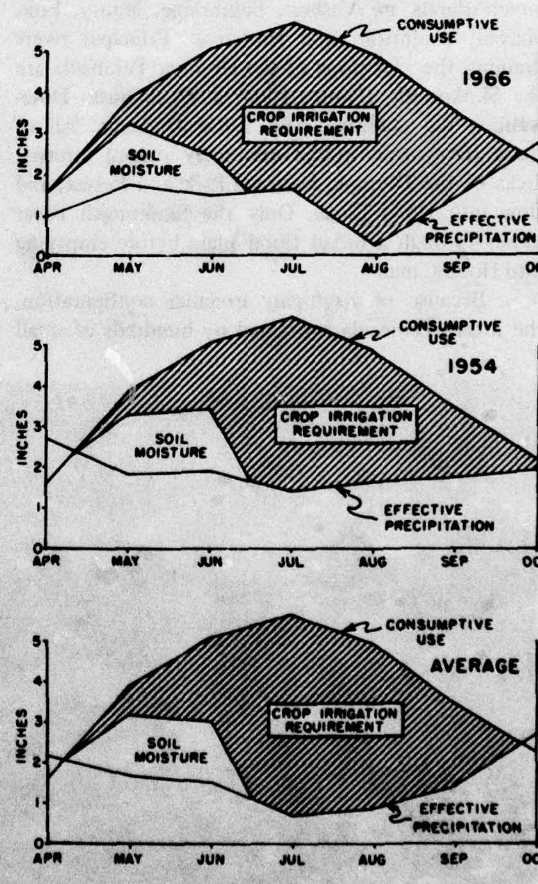



FIGURE 11-1. Crop irrigation requirements for typical dry, wet and average years.


WEST SOUND BASINS

FIGURE 11-2 Irrigation, West Sound Basins

## WATER RESOURCES

### Water Supply

Water is obtained for the irrigated lands from wells and individual diversions from the streams which cross the Basins. Approximately 80 percent of the irrigated lands receive their water supply from surface sources and 20 percent from ground water.

There are striking differences in climate and topography throughout the West Sound Basins. The major streams on the Olympic Peninsula are large and swift as compared to the very small streams that drain the Kitsap Peninsula and the associated islands.

The streams originating in the Olympic Mountains show two distinctly different flow regimens. The northern streams, which lie in the rain shadow of the mountains, exhibit two peak periods of runoff; one in winter and a more prominent peak in late spring. In the southern area, winter peak is more predominant, and tends to merge with the spring peak to provide a long period of high flows extending into May or June. Lowest runoff usually occurs in August or September. The runoff pattern of the South Fork Skokomish River, which is shown in Table 11-1, is typical of a southern Olympic drainage of the West Sound Basins.

The Kitsap Peninsula is drained by hundreds of small stream systems. There are only 12 streams on the Peninsula that drain more than 10 square miles and most streams have drainage areas of less than one square mile. Because of the small drainage areas of the streams and the geographical location in the rainshadow of the Olympic Mountains, the runoff pattern, similar to other low altitude basins, results directly from rainfall. The winter peak occurs in January or February decreasing to the low in September or October. Many of the smaller streams dry up during the months of August through October.

Surface waters of the West Sound Basins are low in dissolved solids and are suitable for irrigation uses. Many of the smaller streams in the Kitsap Peninsula exhibit a distinct color due to dissolved organic material. Sediment problems are associated with high runoff during the nonirrigation season, and therefore few problems are experienced with irrigation use.

At present, only a small part of the ground water is being withdrawn. Most ground water removal is for domestic and livestock use with only a small portion used for irrigation. The largest use of ground water for irrigation is found in the Skokomish River Valley.

Due to a greater amount of surface runoff on the Olympic Peninsula, ground water use there is not extensive. However, high producing wells are found near Port Townsend and Shelton.

At the present, the main problem of groundwater developement is the potential salt-water contamination near the Puget Sound shoreline. Iron is seldom a problem, although it is found to some extent mainly in the ground waters of the Kitsap Peninsula.

### Water Rights

Irrigation rights comprise only 3 percent of total surface and ground water rights. Most of the authorized water use is for domestic and municipal or power purposes. There have been no adjudications of water rights in this area.

As of April 30, 1967, there were 8,000 acres of land in the West Sound Basins that had an application, a permit or a certificate for a surface water

**TABLE 11-1. Monthly and annual runoff—1,000's of acre-feet (Period 1931-1960)**

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOUTH FORK SKOKOMISH RIVER NEAR UNION: (76.3 sq. mi.) | | | | | | | | | | | | | |
| Maximum (1956) | 54.4 | 128.6 | 96.5 | 90.5 | 23.8 | 66.1 | 68.2 | 62.2 | 54.1 | 27.2 | 11.4 | 11.7 | 694.7 |
| Minimum (1944) | 21.2 | 22.0 | 47.8 | 68.0 | 39.2 | 30.5 | 30.6 | 20.4 | 11.7 | 6.4 | 5.0 | 6.3 | 309.1 |
| Mean (1931-60) | 30.9 | 63.1 | 85.2 | 80.2 | 61.6 | 52.4 | 46.7 | 37.7 | 23.4 | 13.5 | 8.1 | 10.1 | 512.9 |
| TAHUYA RIVER NEAR BELFAIR: (16.1 sq. mi.) | | | | | | | | | | | | | |
| Mean (1946-56) | 0.9 | 5.1 | 6.8 | 7.9 | 6.8 | 4.2 | 2.1 | 1.0 | 0.3 | | 0.1 | | 35.2 |
| CHIMACUM CREEK NEAR CHIMACUM: (12.6 sq. mi.) | | | | | | | | | | | | | |
| Mean (1952-56) | 0.4 | 0.7 | 1.6 | 2.2 | 1.8 | 1.6 | 0.9 | 0.5 | 0.5 | 0.3 | 0.2 | 0.2 | 10.9 |

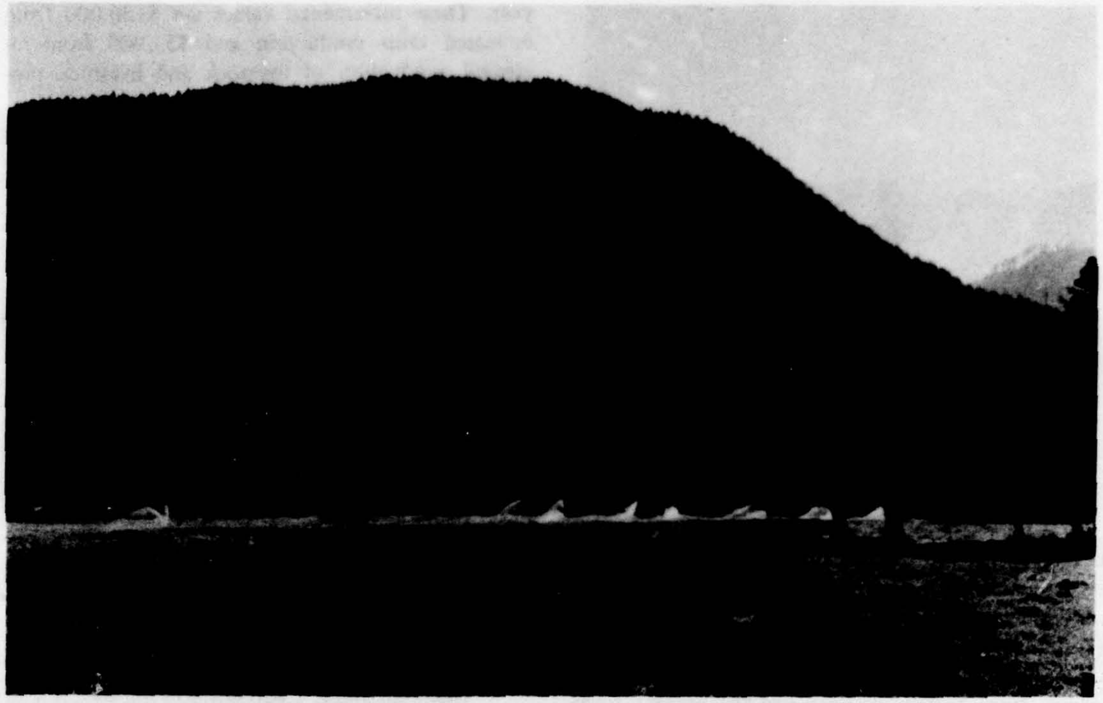


**PHOTO 11-2. Typical of the presently irrigated lands is this pasture in the Skokomish River Valley. (USBR photo)**

right. The total diversion to serve this acreage along with combined stock and domestic water is 100 cubic feet per second. Irrigation ground water rights as of September 30, 1966 totaled about 18 cubic feet per second for 1,500 acres.

## Water Requirements

The irrigation requirements for the West Sound Basins have been estimated using climatological data for adjacent basins. The section of this appendix discussing the Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

Annual consumptive use of the irrigated crops is estimated to be 2.22 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops, would be about 0.77 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.45 acre-feet per acre. With an estimated farm irrigation efficiency of 60 percent, a farm delivery requirement of 2.42 acre-feet per acre would

**TABLE 11-2. Irrigation requirements**

| Item | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| Distribution | 5% | 22% | 30% | 28% | 15% | 100% |
| Crop irrigation requirement (acre-feet/acre) | .07 | .32 | .43 | .41 | .22 | 1.45 |
| Farm delivery requirement (acre-feet/acre) | .12 | .53 | .73 | .68 | .36 | 2.42 |
| Diversion requirement (acre-feet/acre) | .13 | .56 | .77 | .71 | .38 | 2.55 |

PHOTO 11-3. Boom-type sprinklers used for irrigating pasture in the Skokomish River Valley. (USBR photo)

be required. Using this farm delivery requirement and an estimated operational loss and waste of 5 percent of the diverted amount, the presently irrigated lands (1,200 acres) require an average annual diversion of about 3,100 acre-feet. About 80 percent of this comes from surface sources and 20 percent from ground water.

The monthly irrigation requirements are shown in Table 11-2.

Presently irrigated lands would produce an annual net return flow of 900 acre-feet. The resulting depletion of ground and surface water would be 2,200 acre-feet annually.

### Adequacy of Supply

In the majority of instances the quantity of the waters in the West Sound Basins is adequate to meet the present irrigation needs. Ground water is not adequate in certain areas, especially on the Kitsap Peninsula. The shallower wells located there readily reflect the precipitation and the ground water usage. Shortages occur on small drainages, especially those of the Kitsap Peninsula where many small streams become completely dry by late summer.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased livestock production attributable to irrigation in an average year. These incremental values are $136,000 from increased crop production and $51,000 from increased production of livestock and livestock products for a total value of $187,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964, and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock number and production, and value of livestock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type and Size of Farms

There are about 1,770 farms in the West Sound Basins, of which 125 or 7 percent, had irrigated cropland in 1964. As shown in Table 11-3, dairy and other livestock farms are the most common farming enterprises in the Basins identified by source of farm income.

The average sizes of commercial farms in the seven counties in which the Basins are located range from 60 to 290 acres. Farms in the Basins' counties with irrigated cropland in 1964 ranged from nearly 50 acres to almost 230 acres. Commercial farms with milk cows for these counties averaged 16 to 44 cows.

TABLE 11-3. Farm types—1964[1]

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crops | 0 | 0 |
| Vegetable | 10 | .6 |
| Fruit and Nut | 60 | 3.4 |
| Poultry | 70 | 3.9 |
| Dairy | 120 | 6.8 |
| Other Livestock | 150 | 8.5 |
| General | 20 | 1.1 |
| Miscellaneous | 1,340 | 75.7 |
| TOTAL | 1,770 | 100.0 |

[1] Estimated from Census of Agriculture
[2] Rounded to the nearest 5

Nearly 75 percent of the farm types are livestock operations. Dairy and other livestock farms are the most numerous of the farm types with irrigated cropland in the Basins.

## Crops

Total crop production related to irrigation use is shown in Table 11-4.

**TABLE 11-4. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation | |
|---|---|---|---|---|
| | | | Per acre[1] | Total[2] |
| **Forages** | 900 | Ton | -- | -- |
| Corn silage | (50) | Ton | 6.88 | 340 |
| Hay | (370) | Ton | 1.79 | 660 |
| Pasture | (480) | AUM | 4.26 | 2,040 |
| **Vegetables** | | | | |
| Sweet Corn | 80 | Ton | 2.15 | 170 |
| **Berries** | 220 | Ton | 2.14 | 470 |
| Strawberries | (190) | Ton | (2.12) | (400) |
| Raspberries | (30) | Ton | (2.38) | (70) |

[1] See the Puget Sound Area for method of derivation.

[2] Rounded to the nearest 10.

Forage crops are grown on about 90 percent of the irrigated cropland. Most of this acreage is in grass or grass-clover crops used for hay and pasture, although some is in corn silage. The early crop of grass, generally cut in May, is harvested for silage or green feed, because the weather is too wet to make hay or to graze. Later in the season, this cropland is irrigated and harvested as hay or is grazed, although some is cut for green feed all season. Almost all forage crops are used within the Basins.

Sweet corn is the only vegetable crop grown commercially; part of the acreage is irrigated. Most sweet corn is sold to processors.

Strawberries and raspberries are commercially important berry crops that are irrigated. Other berries grown commercially, generally are not irrigated.

## Crop Values

Crop values related to irrigation are shown in Table 11-5.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basins. Meat packing and dairy processing plants are located in the Basins at Bremerton. The derivation of estimated animal units of feed requirements and production is shown in Table 11-6.

**TABLE 11-5. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value: Per Unit[1] (dollars) | Value: Total[2] (dollars) |
|---|---|---|---|---|
| **Forages** | | | | |
| Corn Silage | Ton | 340 | --- | 3 |
| Hay | Ton | 660 | --- | 3 |
| Pasture | AUM | 2,040 | --- | 3 |
| **Vegetables** | Ton | 170 | 26 | 4,400[3] |
| **Berries** | Ton | 470 | 280 | 131,600 |
| **Total** | | | | 136,000 |
| **Rounded** | | | | 136,000 |

[1] Weighted average prices received—adjusted normalized basis
Strawberries—$270/Ton Raspberries—$330/Ton

[2] Rounded to the nearest $200

[3] Accounted for in livestock and livestock product values.

**TABLE 11-6. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | 1.67[2] | 6,120 | 10,220 |
| Per Feeder | .58 | 4,920 | 2,854 |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 5,500 | 6,985 |
| Per Feeder | .38 | 3,500 | 1,330 |
| Total | | | 21,389 |
| Rounded | | | 21,400 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| Forages & Grains | | | |
| Hay-Ton | 660 | .20 | 132 |
| Pasture-Ton | 2,040 | .08 | 163 |
| Small Grains-Ton | -- | -- | -- |
| Corn Silage-Ton | 340 | .07 | 24 |
| Total | | | 319 |
| Rounded | | | 300 |

1 Rounded to the nearest 10 head.
2 Includes feed required for replacements, bulls and young stock usually associated with the breeding herd.
3 Animal Units of feed per ton/AUM.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 1.4 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

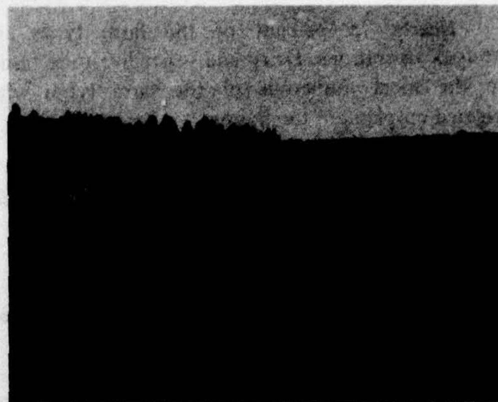


PHOTO 11-4. Irrigating forage on the shores of Leland Lake near Little Quilcene. (USBR photo)

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (TDN) requirements, is shown in Table 11-7. The production is based on 1.4 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 11-6.

In terms of TDN's only, the full feed requirements of about 530 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all of their feed. In reality, the nutritional requirements of many more than 530 head of cattle are partially satisfied by irrigated feeds.

## Livestock and Livestock Product Values

Estimated livestock values related to irrigation are shown in Table 11-8. The value estimates are based on the proportion of feed attributable to irrigation.

**TABLE 11-7. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 12,490 head | 25,200 head | 37,690 head | 1.4 | 530 head |
| Milk | 51,849,000 lbs. | --- | 51,849,000 lbs. | 1.4 | 725,900 lbs. |
| Butterfat in cream | 19,800 lbs. | --- | 19,800 lbs. | 1.4 | 300 lbs. |

1 Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

TABLE 11-8. Estimated livestock and livestock product values related to irrigation

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 2,336,400 | 1.051 | 2,455,556 | 1.4 | 34,400 |
| Cattle and Calves | 1,134,100 | 1.051 | 1,191,939 | 1.4 | 16,700 |
| Total | | | | | 51,100 |
| Rounded | | | | | 51,000 |

1 Prices received—livestock and livestock products

2 Rounded

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the West Sound Basins total 12,850 acres, of which 1,200 are presently irrigated and 11,650 are potentially irrigable. About 2,600 acres are expected to be under irrigation by the year 2020.

### Land Characteristics

Soil within the West Sound Basins have developed under the influence of humid climate and moderate temperatures. They are slightly to moderately acid in the surface soil and become less acid with depth, and are free from accumulations of soluble salts.

In general, the potentially irrigable lands are located in alluvial bottom land areas. Topography is generally smooth to gently undulating. About 20 percent of the lands have varying degrees of drainage problems, which could be alleviated by using tile, shallow surface drains, and improvement of natural channels for removal of excess winter precipitation. The lands are all well-suited to irrigation development.

### Land Classes

Potentially irrigable lands in the West Sound Basins total 11,650 acres, of which 6,580 acres are presently in woodlands. The following tabulation shows the acreage distribution of potentially irrigable lands by land classes:

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 530 | 170 | 700 |
| 2 | 310 | 1,560 | 1,870 |
| 3 | 4,230 | 4,850 | 9,080 |
| Total | 5,070 | 6,580 | 11,650 |

These lands are shown on Figure 11-2.

## PROJECTION OF FUTURE IRRIGATION

Future irrigation development will be limited due to the small and widely scattered parcels of land throughout the Basins, and costs of clearing and developing the land. In addition, meager water supplies on the Kitsap Peninsula also will limit irrigation development in this area. An additional 1,400 acres are projected to be irrigated by 2020: 400 by 1980, 500 by 2000, and 500 by 2020. Irrigation expansion will be mostly along Chimacum Creek, and the Quilcene and Skokomish rivers.

Present and future irrigation water demands are:

| Year | New Irrigation (acres) | Supply Source GW (acres) | Supply Source SW (acres) | Surface Diversions Annual (ac.ft.) | Surface Diversions Peak (cfs) |
|---|---|---|---|---|---|
| Present | -- | 200 | 1000 | 2500 | 15 |
| 1980 | 400 | 100 | 300 | 800 | 5 |
| 2000 | 500 | 100 | 400 | 1000 | 6 |
| 2020 | 500 | 100 | 400 | 1000 | 6 |

Maximum irrigation water requirements for the Basins are:

| | |
|---|---|
| Peak farm delivery requirement | 69 acre/cfs |
| Farm delivery requirement | 2.42 acre-feet/acre |
| Diversion requirement | 2.55 acre-feet/acre |

The monthly distribution of the irrigation requirements is shown as percent of annual demand.

| | |
|---|---|
| May | 5% |
| June | 22% |
| July | 30% |
| August | 28% |
| September | 15% |
| TOTAL | 100% |

The potentially irrigable lands are distributed as follows:

| Location | Potentially Irrigable Cleared (acres) | Potentially Irrigable Trees (acres) | Total (acres) |
|---|---|---|---|
| Chimacum Creek | 3,110 | 2,500 | 5,610 |
| Quilcene River | 750 | 730 | 1,480 |
| Skokomish River | 960 | 1,370 | 2,330 |
| Indian Reservation | 250 | 1,980 | 2,130 |
| TOTAL | 5,070 | 6,580 | 11,650 |

## MEANS TO SATISFY NEEDS

Water supplies are adequate to meet the projected irrigation water requirements.

Project-type developments are not anticipated in the Basins. Future development will probably be by private means by pumping from the various streams and ground water through individual farm irrigation systems. The projected investment costs for the West Sound Basins is shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $50,000 | -- |
| 1980-2000 | $70,000 | -- |
| 2000-2020 | $70,000 | -- |

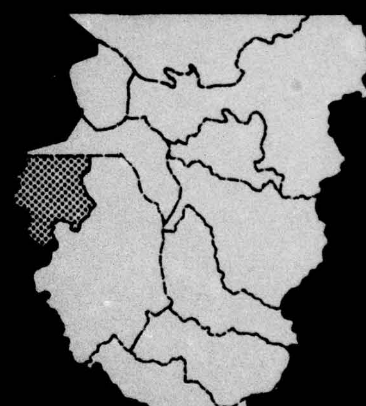
For the 1980 level of development the annual operating costs are estimated to be $4,800. Costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new and potentially-irrigable lands would amount to approximately $160 per acre, and are summarized as follows:

| Year | New Irrigation (acres) | Farmers increased annual gross income |
|---|---|---|
| 1980 | 400 | $64,000 |
| 2000 | 500 | 80,000 |
| 2020 | 500 | 80,000 |

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

# Elwha-Dungeness Basins



# ELWHA-DUNGENESS BASINS

The Elwha-Dungeness Basins in the northeast corner of the Olympic Peninsula contain two major river basins, and a number of smaller basins draining the northern slopes of the Olympic Mountains. The Elwha River drains 321 square miles of mountainous area reaching into the heart of the Olympic National Park and contains outstanding timber and recreational resources. The Dungeness River drains 198 square miles of similarly spectacular area and empties into the Strait of Juan de Fuca as does the Elwha. Between the two major rivers are eight smaller streams draining a foothill and coastal plain of 170 square miles.

A large part of the Basins is in densely timbered wilderness with steep mountain slopes and rugged foothills. The flanking foothills of the Olympic Mountains give way to upland slopes, terraces, and stream bottoms which merge into a small, gently undulating plain bordering the Strait of Juan de Fuca. Away from the mountains, most of the area is covered with glacial deposits of gravelly till and outwash sediments, and recent alluviums of the stream valleys.

Proximity to the Strait of Juan de Fuca has a moderating effect on the climate of the Basins, and the shielding effect of the Olympic Mountains gives them a distinct semi-arid character. Annual precipitation in the lower elevations is about 16 inches with only about 30 percent occuring between April and September. A fairly high incidence of sunshine, absence of destructive winds, and a growing season of about 195 days make the Basins suitable for a variety of crops. Meager precipitation during the growing season, however, is a major handicap.

Lands above the alluvial bottoms vary widely in texture and are used for cropland and woodland. Woodland use predominates as the elevation increases. Much of the higher mountainous areas of forest lands are in Federal ownership. Land use in the Basins is shown below.

| | Acres |
|---|---|
| Cropland | 24,000 |
| Rangeland | 2,000 |
| Forest | 409,000 |
| Rural nonagricultural | 5,000 |
| Built-up areas | 6,000 |
| TOTAL | 446,000 |

The economy of the basins is based primarily on agriculture, tourism, and timber and wood products. Paper production is the largest industry, providing employment for about 550 people in manufacturing and an additional 200 working in the woods. Commercial agriculture, representing about 85 percent of the agricultural lands, is almost exclusively devoted to dairy production.

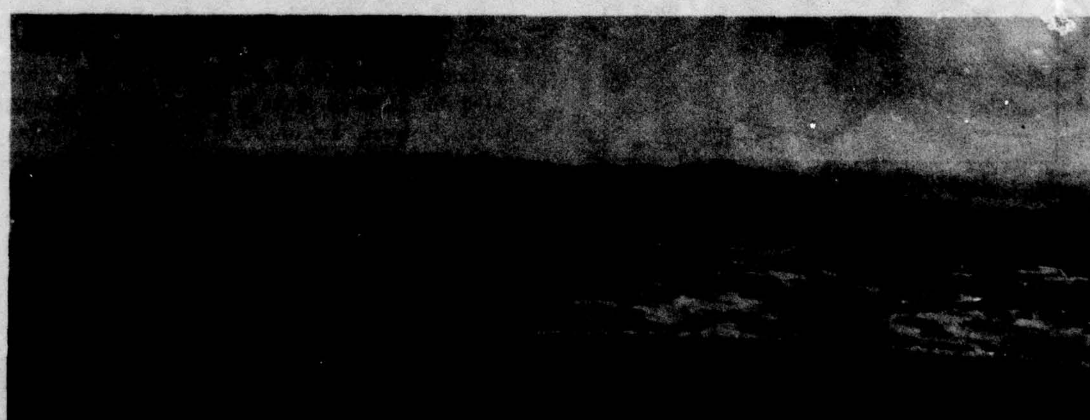


**PHOTO 12-1. Dungeness River Alluvial Plain with the Olympic Mountains in the background and the Strait of Juan de Fuca in the foreground. (USBR photo)**

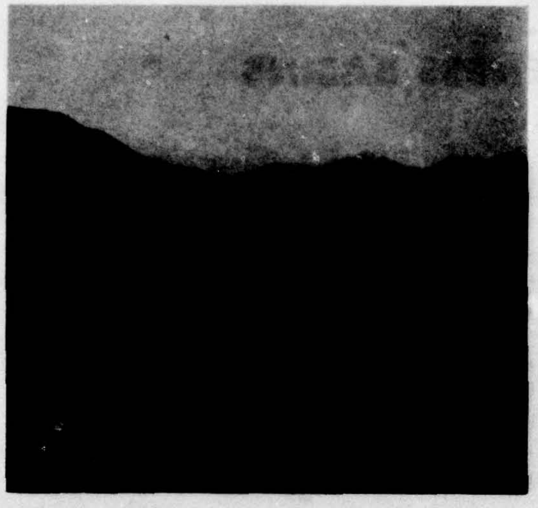


PHOTO 12-2. Irrigated pasture south of Sequim. (USBR photo)

Agricultural development has occurred primarily in the eastern portion of the Basins on a small plain around the town of Sequim. This area is the only agricultural district of significance in the northern part of the Olympic Peninsula. Irrigation is important to successful farming, as is evident by the major irrigation systems that have been developed since 1895.

Recreational opportunities are varied and numerous. Major areas of the Basins are in and adjacent to the Olympic National Park. The long coastline bordering the Strait of Juan de Fuca with its many bays and coves offers additional recreational opportunities.

There were about 28,500 people living in the Basins in 1967, with Port Angeles and Sequim being the two major population centers. Port Angeles had a population of 15,800 while Sequim, the trade center for the agricultural area, had 1,450.

# PRESENT STATUS

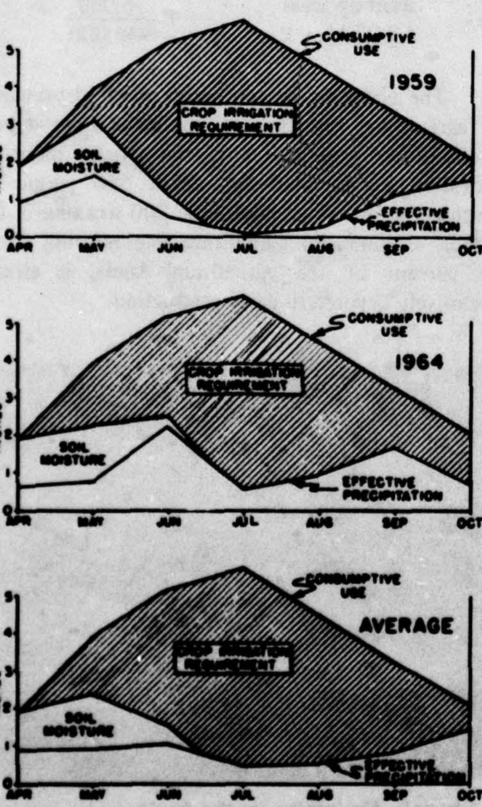



FIGURE 12-1. Crop irrigation requirements for typical, dry, wet and average years.

As early as 1895, a group of farmers on the prairie near Sequim organized the Sequim Prairie Ditch Company, and constructed the first facilities for diversion of water from the Dungeness River. During the next decade several individual enterprises were started and three additional companies organized. Subsequently, during the period from 1911 to 1921, practically all of the remaining irrigable lands were included within the boundaries of the various ditch companies and irrigation districts. These boundaries surround the present irrigated lands.

The semi-arid climate of the Sequim area, which is similar to Eastern Washington, has resulted in extensive irrigation development. Unlike other areas in Puget Sound, there is little change in acreage irrigated between wet and dry years. During 1966, about 15,900 acres were irrigated and this is considered to be the normally irrigated acreage. Also, unlike other basins, the crop irrigation requirement varies only slightly from year to year as shown in Figure 12-1.

## IRRIGATED LANDS

Nearly all irrigation development in the Elwha-Dungeness Basins has occurred on the Dungeness River alluvial plain in the vicinity of Sequim; a small plain between the steep foothills of the Olympic Mountains and the Strait of Juan de Fuca.

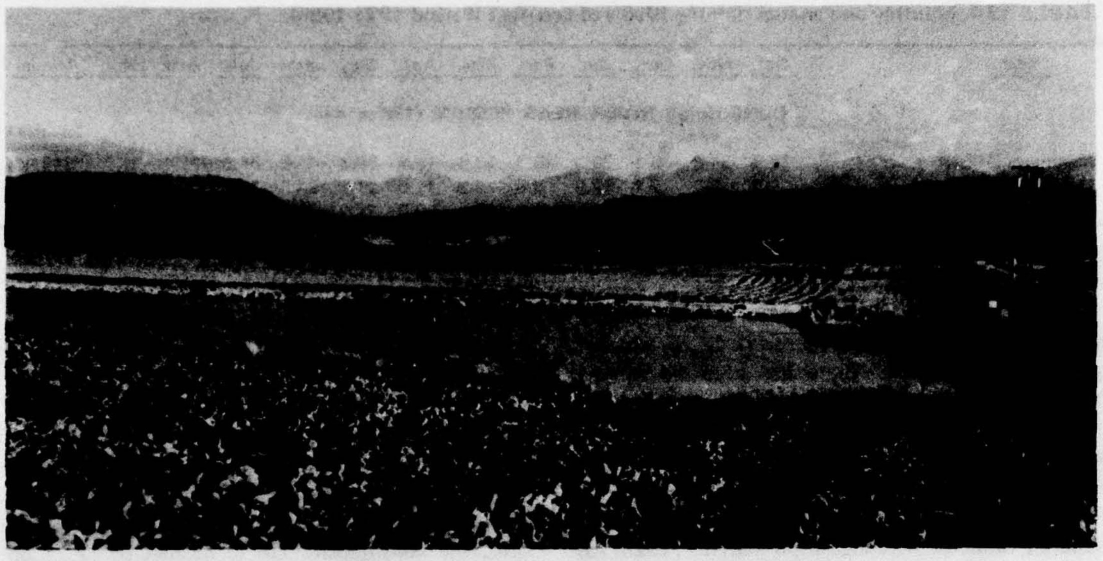


PHOTO 12-3. The Olympic Mountains and Dungeness River watershed form the backdrop for gently sloping irrigated lands. (USBR photo)

The soils have developed upon a wide variety of parent materials, the chief of which are gravelly glacial drift, including glacial outwash deposits of gravel and sand, and silt derived from many sources. Surface textures range from gravelly loams to silt loams, and the soils in general are fairly deep and friable.

Topography of the irrigated lands ranges from nearly level to gently sloping and undulating. Both gravity and sprinkler irrigation are used in the area with the use of sprinkler application increasing, especially on newly developed lands.

Presently irrigated lands in the Elwha-Dungeness Basins were mapped as Classes 1, 2 or 3 depending upon their relative suitability for irrigation development. The lands classified are shown on Figure 12-2. A summary of the lands irrigated in 1966, is shown below.

| Land Class | Irrigated (acres) |
|---|---|
| 1 | 3,240 |
| 2 | 6,770 |
| 3 | 5,890 |
| TOTAL | 15,900 |

An explanation of land classification procedures and criteria used in this study is given in the section of this appendix which discusses The Puget Sound Area.

## WATER RESOURCES

### Water Supply

Water supply for the irrigated lands is obtained primarily from surface diversions and over 90 percent of the lands are served from the Dungeness River or its tributaries. Four irrigation districts and five ditch companies provide service to most of the irrigated area on the Dungeness River alluvial plain. The acreage served from the Elwha River is negligible.

The Dungeness River has two periods of high runoff as shown in Table 12-1; one in December or January and another during May or June. Lowest runoff occurs in September and October. Approximately 60 percent of the runoff occurs during the irrigation season.

Surface water is of excellent quality for irrigation use. This is evidenced by analyzed water samples and more than 60 years of use with no apparent harmful effects to soils or crops. Sediment problems are generally localized and occur during periods of high runoff. Sediment transport is low during the irrigation season.

Ground water supplies are adequate for general farm use and the Dungeness alluvial plain has a potential water supply capable of sustaining some irrigation. However, most wells yield less than 200 gallons per minute and this severely limits the acreage which can be irrigated from a single well. The most

TABLE 12-1. Monthly and annual runoff—1000's of acre-feet (Period 1931-1960)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DUNGENESS RIVER NEAR SEQUIM (156 sq. mi.) | | | | | | | | | | | | | |
| Maximum (1954) | 17.8 | 34.6 | 35.1 | 30.3 | 45.3 | 23.6 | 18.5 | 39.3 | 44.5 | 51.6 | 32.1 | 21.7 | 349.4 |
| Minimum (1944) | 9.2 | 8.2 | 12.7 | 12.0 | 7.8 | 9.9 | 11.0 | 21.1 | 24.5 | 13.5 | 8.0 | 6.5 | 144.4 |
| Mean | 12.7 | 19.6 | 25.3 | 22.5 | 19.8 | 16.6 | 20.0 | 37.7 | 43.3 | 31.5 | 16.4 | 10.5 | 275.9 |

productive wells are found east of McDonald Creek toward the coastline.

Although the ground water is more highly mineralized than surface water, it is of suitable quality for irrigation. There has been no known intrusion of sea water into existing wells.

## Water Rights

Rights to the use of waters of the Dungeness River and its tributaries were adjudicated by the Superior Court of Washington on March 7, 1924. All adjudicated rights are irrigation rights. The adjudication was for 29,000 acres,but less than two-thirds of this land is actually irrigated. The quantity of water allowed was one cubic foot per second for each 50 acres for a total of 579.56 cubic feet per second (6 acre-feet per acre). Since the adjudication, and up to April 30, 1967, additional surface water permits and certificates have been recorded for about 50 cubic feet per second in the Dungeness River drainage, which include additional irrigation rights of nearly 20 cubic feet per second, fishery rights of 25 cubic feet per second and municipal rights for Sequim of 1.4 cubic feet per second. (Miscellaneous rights make up the remainder.) Table 12-2 lists the adjudicated rights by priority classes.

In addition to the adjudication, a total maximum surface appropriation of 52 cubic feet per second for the irrigation of 4,200 acres is on record for the entire Elwha-Dungeness Basins. Surface rights on the small coastal drainages serve approximately 2,940 acres. Several of these smaller streams are becoming heavily appropriated. Surface irrigation rights along the Elwha River are for less than 100 acres.

Irrigation ground water right permits and certificates total about 16 cubic feet per second for 1,200 acres.

## Water Requirements

The irrigation requirements were estimated using climatological data from the Sequim station. The average precipitation at Sequim for the months of June, July and August totals about two inches. The section of this appendix discussing The Puget Sound Area gives a detailed explanation of the procedures and criteria used in developing the water requirements.

Annual consumptive use of the irrigated crops is estimated to be about 2.21 acre-feet per acre. Precipitation and soil moisture that would be effective in meeting consumptive use requirements of crops would be about 0.65 acre-feet per acre in a dry year. Thus, the consumptive use to be met by irrigation would be 1.56 acre-feet per acre. With an estimated farm irrigation efficiency of 60 percent, a farm delivery requirement of 2.60 acre-feet per acre would be required. Using this farm delivery requirement and an estimated operational loss and waste of 45 percent of the diverted amount, the presently irrigated lands (15,900 acres) require an average annual diversion of

TABLE 12-2. Adjudicated water rights Dungeness River

| Owner | Priority Class | Area acres | Appropriation c.f.s. |
|---|---|---|---|
| Sequim Prairie Ditch Co. | 1 | 1,000 | 20.00 |
| Eureka Irrig. & Milling Co. | 2 | 1,154 | 23.08 |
| Samuel Woodcock | 3 | 200 | 4.00 |
| George W. Lawrence | 4 | 50 | 1.00 |
| Clallam Ditch Co. | 5 | 3,000 | 60.00 |
| Private Operators (7) | 6 | 202 | 3.84 |
| Independent Irrig. Co. | 7 | 2,000 | 40.00 |
| Bessie & Thomas Tiller (Canyon Creek) | 7 | 10 | 0.20 |
| Dungeness Irrig. Co. | 8 | 3,547 | 70.94 |
| Highland Irrig. Dist. | 9 | 3,507 | 70.14 |
| Happy Valley Irrig. Dist.[1] | 10 | 2,618 | 52.36 |
| Agnew Irrig. Dist.[2] | 11 | 7,300 | 146.00 |
| Cline Irrig. Dist. | 12 | 2,300 | 46.00 |
| Dungeness Irrig. Dist. | 13 | 2,100 | 42.00 |
| TOTAL | | 28,988 | 579.56 |

1 Project was never completed.

2 The adjudication lists this appropriation as MacLeay-Lindsey Irrigation District but it is known locally as the Agnew Irrigation District.

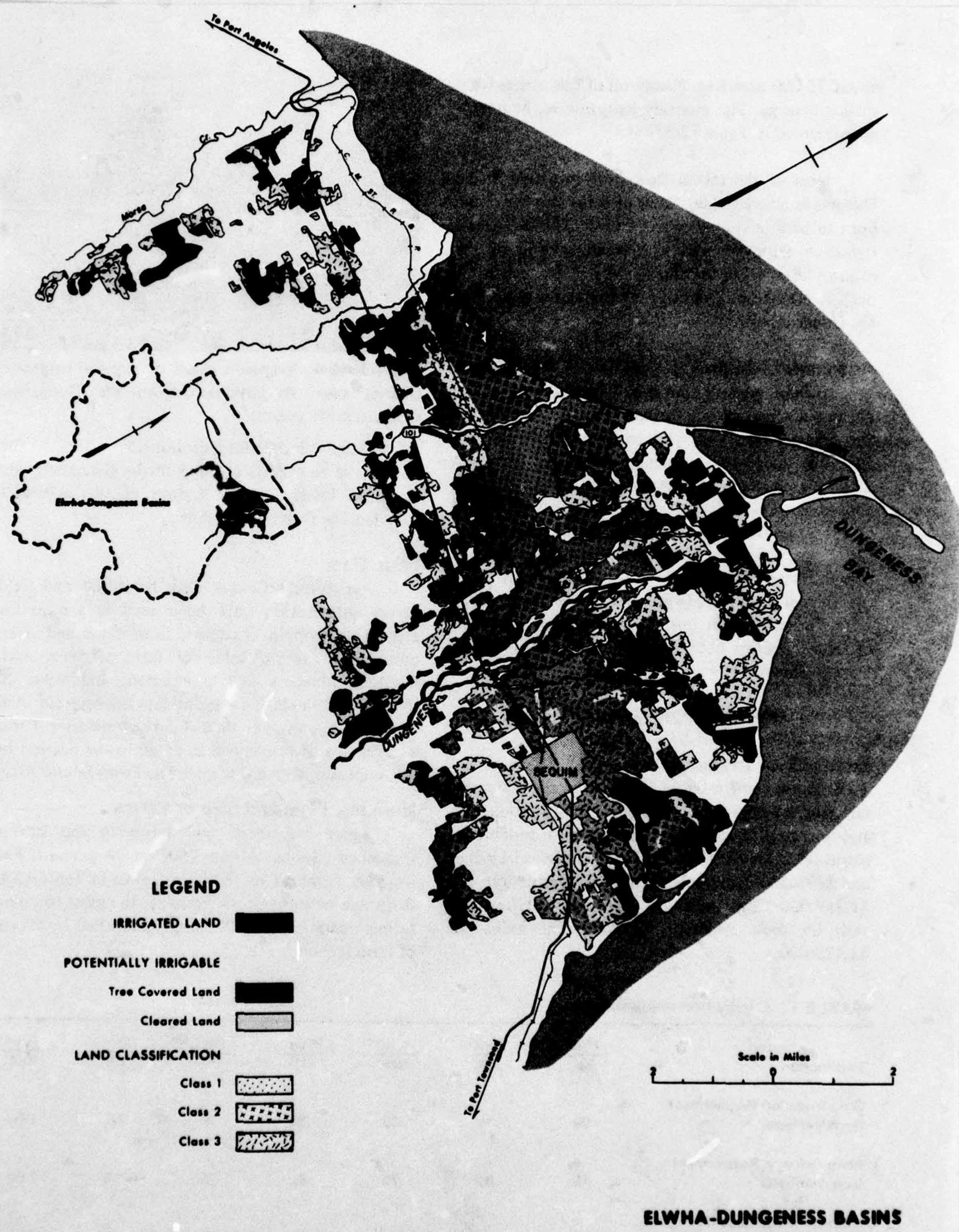



**FIGURE 12-2 Irrigation, Elwha-Dungeness Basins**

about 75,000 acre-feet. Nearly all of this comes from surface sources. The monthly irrigation requirements are presented in Table 12-3.

Most of the return flow from irrigation in the Dungeness alluvial plain flows directly into the ocean but can be intercepted in some cases. The Dungeness Irrigation District recovers a small amount of the return flow from a small stream for reuse. A negligible portion of return flow finds its way back to the Dungeness River.

### Adequacy of Supply

Irrigation water shortages occur because of the normal decline in late season natural flow of the Dungeness River. Water is usually available through July but under the efficiency of exising irrigation methods, shortages are experienced in August and September. Factors contributing to the low efficiency of existing systems are: (1) duplication of facilities; (2) lands having water rights in more than one organization; (3) high conveyance losses and operational waste, and (4) farm irrigation methods.

To supplement inadequate supplies, a number of farm operators obtain irrigation water by pumping from shallow wells.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased crop production and increased livestock production attributable to irrigation in an average year. These incremental values are $170,000 from increased crop production and $1,259,000 from increased production of livestock and livestock products for a total value of $1,429,000.

PHOTO 12-4. Irrigation ditch of Agnew Irrigation District near its diversion from the Dungeness River. (USBR photo)

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964 and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers and production, and value of livestock products. The census data has been adjusted to reflect basin rather than county boundaries. These adjustments are explained in detail in the Section of this appendix which discusses The Puget Sound Area.

### Number, Type and Size of Farms

There are about 640 farms in the Elwha-Dungeness Basins. About 250, or 39 percent, had irrigated cropland in 1964. As shown in Table 12-4, dairy and other livestock farms are the most common farming enterprises in the basins identified by source of farm income.

TABLE 12-3. Irrigation requirements

| Item | May | June | July | Aug | Sept | Oct. | Total |
|---|---|---|---|---|---|---|---|
| Distribution | 6% | 23% | 29% | 21% | 15% | 6% | 100% |
| Crop Irrigation Requirement (acre-feet/acre) | .09 | .36 | .45 | .33 | .24 | .09 | 1.56 |
| Farm Delivery Requirement (acre-feet/acre) | .15 | .62 | .75 | .55 | .38 | .15 | 2.60 |
| Diversion Requirement (acre-feet/acre) | .28 | 1.09 | 1.37 | 1.00 | .71 | .28 | 4.73 |

**TABLE 12-4. Farm types—1964[1]**

| Type of Farm | Estimated Number in Basins[2] | Percent of Total |
|---|---|---|
| Field Crops | 0 | 0 |
| Vegetable | 0 | 0 |
| Fruit and Nut | 5 | .8 |
| Poultry | 5 | .8 |
| Dairy | 75 | 11.7 |
| Other Livestock | 65 | 10.2 |
| General | 25 | 3.9 |
| Miscellaneous | 465 | 72.6 |
| TOTAL | 640 | 100.0 |

1 Estimated from Census of Agriculture.
2 Rounded to the nearest 5.

The average size of commercial farms is about 150 acres and farms with irrigated cropland average about 110 acres. Commercial farms with milk cows average about 35 cows per farm.

Nearly 95 percent of the irrigated cropland is in forage crops. Dairy farms and other livestock farms comprise the bulk of the farms with irrigated cropland.

**TABLE 12-5. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Production Related to Irrigation Per Acre[1] | Production Related to Irrigation Total[2] |
|---|---|---|---|---|
| Small Grains | 20 | Ton | .50 | 100 |
| Field Crops | 710 | | | |
| Dry Peas | (210) | Ton | .49 | 100 |
| Mint | (500) | Cwt | .60 | 300 |
| Forages | 15,020 | | | |
| Hay | (6,460) | Ton | 2.71 | 17,510 |
| Pasture | (8,560) | AUM | 6.45 | 55,210 |
| Vegetables | | | | |
| Green Peas | 60 | Ton | 1.12 | 70 |
| Berries | 90 | Ton | 2.11 | 190 |
| Strawberries | (70) | Ton | (2.21) | (150) |
| Raspberries | (20) | Ton | (2.10) | (40) |
| TOTAL | 15,900 | | | |

1 See The Puget Sound Area for method of derivation.
2 Rounded to the nearest 10.

PHOTO 12-5. Domesticated geese used for weed control on a mint farm near Sequim. (USBR photo)

## Crops

Total crop production related to irrigation use is shown in Table 12-5.

The lack of large population centers in the Basins to support fresh markets, and the long distances and travel time involved in shipping to processors, have severely limited the production of perishable crops such as vegetables and berries. The Elwha-Dungeness Basins have the highest acreage of alfalfa grown in the Puget Sound Area. Some forage is cut for silage and green feed as well as for hay. Over 50 percent of the irrigated forage cropland is used for pasture production.

Field crops grown in the Basins are dry peas and mint. The Elwha-Dungeness Basins are one of two locations in the Puget Sound Area where mint is grown commercially. Most of the mint oil is used by manufacturers and processors for flavoring products sold in regional and national markets. Dry peas are grown in the Basins and are marketed locally. All of the mint and most of the peas are irrigated.

Irrigated green peas and brussel sprouts have been grown on a commercial basis during recent years. Most of these vegetables are shipped to Seattle for processing. Because brussel sprouts are a relatively new crop, only green peas have been considered in determining the effect of irrigation on vegetable production.

Irrigated strawberries and raspberries are grown commercially in the Basins. Most of the berries are processed in Winslow, about 55 miles southeast of Sequim.

**TABLE 12-6. Estimated crop values related to irrigation**

| Crop | Unit of Production | Increased Production Related to Irrigation | Value: Per Unit (dollars) | Value: Total (dollars) |
|---|---|---|---|---|
| Small Grains | Ton | 10 | -- | [1] |
| **Field Crops** | | | | |
| Dry Peas | Ton | 100 | 84 | 8,400 |
| Mint | Cwt | 300 | 340 | 102,000 |
| **Forages** | | | | |
| Hay | Ton | 17,510 | -- | [1] |
| Pasture | AUM | 55,210 | -- | [1] |
| Vegetables | Ton | 70 | 93 | 6,500[2] |
| Berries | Ton | 190 | 280[3] | 53,200 |
| Total | | | | 170,100 |
| Rounded | | | | 170,000 |

1 Accounted for in livestock and livestock product values.
2 Rounded to the nearest $100.
3 Average prices received—adjusted normalized basis.
Strawberries—$270/Ton Raspberries—$330/Ton

**Table 12-7. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| **Dairy Cattle** | | | |
| Per Cow | 1.67[2] | 3,850 | 6,430 |
| Per Feeder | .58 | 1,260 | 731 |
| **Beef Cattle** | | | |
| Per Cow | 1.27[2] | 4,060 | 5,156 |
| Per Feeder | .38 | 1,220 | 464 |
| Total | | | 12,781 |
| Rounded | | | 12,800 |

| Item | Amount Produced | Animal Unit Equivalents[3] | Total Animal Units Production |
|---|---|---|---|
| **Forages and Grains** | | | |
| Hay—Ton | 17,510 | .20 | 3,502 |
| Pasture—AUM | 55,210 | .08 | 4,417 |
| Small Grains—Ton | 10 | .29 | 3 |
| Corn Silage—Ton | --- | --- | --- |
| Total | | | 7,922 |
| Rounded | | | 7,900 |

1 Rounded to the nearest 10 head.
2 Includes feed required for replacements, bulls and young stock normally associated with the breeding herd.
3 Animal Units of feed per ton/AUM

## Crop Values

Crop values related to irrigation are shown in Table 12-6.

## Livestock

Cattle operations, primarily dairying, are the major livestock enterprises in the Basins. Meat packing plants are located in Bremerton, about 50 miles southeast of the Basins. Dairy products are marketed and processed in the Basins at Port Angeles. The derivation of estimated animal units of feed requirements and production is shown in Table 12-7.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 61.7 percent of the total feed required in the Basins. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (TDN) requirements, is shown in Table 12-8. The production is based on 61.7 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 12-7.

In terms of TDN's only, the full feed require-

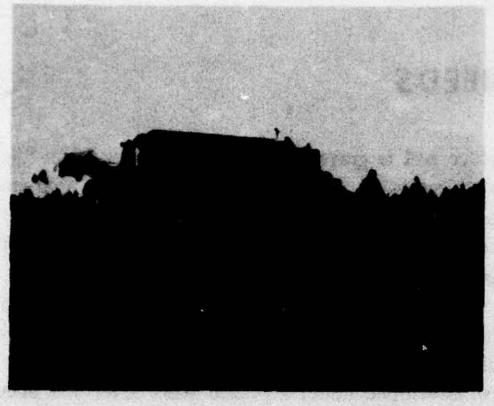


**PHOTO 12-6. Harvesting peas on farm west of Sequim. (USBR photo)**

**PHOTO 12-7. Strawberries being irrigated during August. (USBR photo)**

ments of about 13,640 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few farmers in the Basins raise all of their feed. In reality, the nutritional requirements of many more than 13,640 head of cattle are partially satisfied by irrigated feeds.

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 12-9. The value estimates are based on the proportion of feed attributable to irrigation.

**TABLE 12-8. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation[1] |
|---|---|---|---|---|---|
| Cattle and Calves | 5,980 head | 16,120 head | 22,100 head | 61.7 | 13,640 head |
| Milk | 30,705,600 lbs. | --- | 30,705,600 lbs. | 61.7 | 18,945,300 lbs. |
| Butterfat in cream | 10,000 lbs. | --- | 10,000 lbs. | 61.7 | 6,200 lbs. |

[1] Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 12-9. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Dairy Products | 1,341,600 | 1.051 | 1,410,021 | 61.7 | 870,000 |
| Cattle and Calves | 599,600 | 1.051 | 630,179 | 61.7 | 388,800 |
| Total | | | | | 1,258,800 |
| Rounded | | | | | 1,259,000 |

[1] Prices received—livestock and livestock products.

$$\frac{\text{Long-term adjusted normalized index}}{\text{1984 index}} = \frac{247}{235} = 1.051$$

[2] Rounded.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands in the Elwha-Dungeness Basins total 24,960 acres, of which 15,900 are presently irrigated and 9,060 are potentially irrigable. It is expected that a total of about 22,000 acres will be under irrigation in the Basins by the year 1980.

### Land Characteristics

Most of the potentially irrigable lands are on a narrow, undulating, shelflike plain which borders the Strait of Juan de Fuca, sloping gently from elevations of 1,800 feet or less in the foothills to bluffs of 50 to 200 feet along the beaches. Streams crossing the plain have cut courses through narrow valleys bordered by steep slopes. Between the streams considerable areas retain an unaltered glacial-drift type of relief, characterized by small undrained depressions and low morainic hills. The potentially irrigable lands are, for the most part, located on both glacial material and recent alluviums of the stream valleys.

Soils of the Basins have developed under a wide variety of parent materials, including primarily gravelly glacial drift. The soils occur in four groups: bottom land soils, terrace soils, upland soils, and organic soils.

Bottomland soils are of relatively recent deposition and consist entirely of unconsolidated sediments. These soils are naturally fertile and generally quite productive. Topography varies with locations in gentle slopes, undulating tracts, and some nearly flat plains.

Five types of terrace soils are present:

1. Soils composed of fine sandy loam or loamy fine sand, which have a surface relief ranging from undulating to gently rolling and that are droughty and low in productivity.

2. Those soils on nearly flat benchlands that have been formed on glacial outwash sediments which are predominantly of medium or fine texture. Usually these soils are slightly acid in reaction and low in fertility, but under good farm management will produce favorable yields.

3. Those terrace soils limited to ancient gravelly fan deposit built by the Dungeness River. The surface soil is gravelly loam over shallow loam-filled gravel subsoils. Topography is gently sloping and slightly undulating. This type of soil is generally of inferior quality but a considerable acreage is used for pasture.

4. Soils occuring in association with type (3), which they closely resemble except in their surface soil which is very dark brown or black. These soils have developed under a prairie grass cover and occur on lands which are gently sloping and slightly undulating.

5. This category of terrace soils is quite variable, being assorted into beds of fine and coarse gravels with some layers of coarse sand. The soils occur on generally rolling topography in old gravelly outwash formed by ancient streams. They cover only a small area and are the least productive of the terrace soils.

There are two types of upland soils: (1) those soils found on the undulating upland plain in the eastern part of the area and on the foothill slopes, and (2) soils which have developed primarily upon sediments laid down in shallow lakes which once occupied the glacial depressions. The first are variable, and the texture ranges from medium to fine, and they are slightly acid in reaction. Surface soils of the second type are typically of fine mixture, very dark grayish brown or black. The subsoil is a compact clay developed upon beds of silt and sand which are relatively impervious.

The organic soils are a few small tracts of muck and peat which, for the most part, have not been drained or used for anything other than pasture. If properly drained, some of the deeper beds of muck or peat would be well-suited for specialty crops.

Most of the agricultural area has been cleared of native vegetation. About 13 percent of the potentially irrigable lands, however, support dense second growth timber. Many farmers are clearing a few acres of this land every year and placing it into production. Clearing of the land results in a fairly substantial investment to the farmer. Present estimate of costs for clearing ranges from $300 to $500 per acre. The cost to remove stumps and brush after the timber is cut is $150 to $250 per acre.

## Land Classes

Potentially irrigable lands in the Elwha-Dungeness Basins total 9,060 acres, of which 3,170 acres are presently in woodlands. The following tabulation shows the acreage distribution of the potentially irrigable lands by land classes.

| Land Class | Potentially Irrigable Cleared (acres) | Potentially Irrigable in Tree Cover (acres) | Total (acres) |
|---|---|---|---|
| 1 | 420 | 80 | 500 |
| 2 | 2,220 | 910 | 3,130 |
| 3 | 3,250 | 2,180 | 5,430 |
| Total | 5,890 | 3,170 | 9,060 |

Location of these lands is shown on Figure 12-2.

## PROJECTION OF FUTURE IRRIGATION

Projections are that about 6,100 acres of new lands will be developed for irrigation by 1980. If these lands are provided a water supply through the existing ditch system, the irrigation water demands for the area will be as follows:

| | |
|---|---|
| Peak farm delivery requirement | 70 acres/cfs |
| Farm delivery requirements | 2.60 acre-feet/acre |
| Diversion requirements | 4.73 acre-feet/acre |

The monthly distribution of the irrigation requirement is shown below as percent of annual demand.

| | |
|---|---|
| May | 6% |
| June | 23% |
| July | 29% |
| August | 21% |
| September | 15% |
| October | 6% |
| TOTAL | 100% |

If the lands are served through the existing system or a similar system the diversion requirements would be as shown in the following tabulation.

| Year | Irrigation (acres) | Surface Diversion Annual (ac. ft.) | Surface Diversion Peak[1] (c.f.s.) |
|---|---|---|---|
| Present | 15,900 | 75,000 | 330 |
| 1980 | 22,000 | 104,000 | 450 |
| 2000 | 22,000 | 104,000 | 450 |
| 2020 | 22,000 | 104,000 | 450 |

[1] Peak day within maximum month with existing ditch system.

# MEANS TO SATISFY NEEDS

Natural streamflows of the Dungeness River are not adequate to meet fully the present irrigation demands of the Sequim area. This is due primarily to high conveyance losses and inefficiency of the existing ditch system. Some method of improving the existing water supply will be required to bring new lands under irrigation in the future. Some of the alternative means of improving the water supply are: (1) Development of a system of wells to supplement flows of the Dungeness River and provide a firm source of supply for the new lands; (2) Development of upstream storage to supplement natural flows of the Dungeness River; and (3) Replacement of existing unlined ditch water supply systems with a pipe distribution system which would allow better use of natural streamflows to the extent that all projected lands could be served with no storage or supplemental pumping.

PHOTO 12-8. Present irrigation practices result in high water use. (USBR photo)

From available information, it appears that ground-water yields are barely adequate for supplemental pumping under present conditions. It is doubtful that there is an adequate ground water supply to sustain any significant increase in irrigation demand. Upstream storage would be very costly and, although irrigation demands could be met in this manner, other water uses in the basin would suffer.

Replacement of the existing ditch systems with a pipe distribution system, would conserve water, not only for irrigation, but for other uses as well. This type of system would probably be the least costly and the most efficient method of improving the irrigation supply of the Sequim area.

The updated, closed-pipe distribution system would provide water by gravity at sprinkler pressure for an irrigable area of 22,000 acres. This includes 6,100 acres of new lands. With this updated system, the water supply would be distributed evenly and all lands would have an adequate and dependable water supply. Water for the irrigation system would be provided by direct diversion of natural flows into project laterals, one on each side of the river, leading to two regulating reservoirs near Sequim, beyond which water would be conveyed to the farmlands through a pipe distribution system.

With the updated irrigation system, the distribution losses would be reduced from the present 45 percent to five percent. Present-day irrigation diversions would then be reduced from 75,000 acre-feet to 44,000 acre-feet.

With the 22,000 acres projected to be irrigated by 2020, the total diversion would be 60,000 acre-feet annually; 15,000 acre-feet less than the amount presently being diverted as shown in the following tabulation:

| Year | Irrigation (acres) | Surface Diversion Annual (ac. ft.) | Surface Diversion Peak[1] (c.f.s.) | Net Depletion Surface (ac. ft.) |
|---|---|---|---|---|
| Present | 15,900 | 44,000 | 230 | 44,000 |
| 1980 | 22,000 | 60,000 | 315 | 60,000 |
| 2000 | 22,000 | 60,000 | 315 | 60,000 |
| 2020 | 22,000 | 60,000 | 315 | 60,000 |

[1] Peak day within Maximum month.

The costs and benefits for the project system are shown in the following tabulation:

| | Capital Cost | Annual Cost Capital[1] | Annual Cost OmM.&R. | Annual Benefit | Net Benefit |
|---|---|---|---|---|---|
| Irrigation | $14,610,000 | $684,000 | $117,000 | $1,467,000 | $666,000 |

[1] 4-5/8% @ 100 yrs.

As can be noted, the total annual net benefits are sufficient to economically justify constructing the irrigation facilities.

The cost of the individual farm sprinkler system must be added to the project costs. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

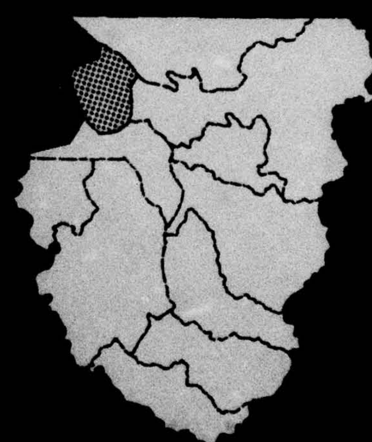
For the 1980 level of development the annual operating costs are estimated to be $120,000. The operating costs include power, operation, maintenance and replacement costs.

The projected investment costs for the Elwha-Dungeness Basin is shown in the following tabulation:

| | Private | Federal |
|---|---|---|
| Present-1980 | $770,000 | $14,610,000 |
| 1980-2000 | -- | -- |
| 2000-2020 | -- | -- |

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.

# San Juan Islands



# SAN JUAN ISLANDS

The San Juan Islands study area comprises all of San Juan County, the smallest county of the State in terms of land area and population. The outstanding feature, however, is its scenic attractions, characterized by a most unusual combination of islands, channels, protected bays and harbors.

The study area is composed of 172 islands which have a land area of about 177 square miles. The principal islands and their approximate surface areas are: Orcas Island with 57 square miles; San Juan, 56; Lopez, 30; Shaw, 8; Blakely, 7; Decatur, 3; and Waldron Island with 5 square miles. There are 13 smaller islands having an area over 100 acres and 152 others having an area of less than 100 acres.

Access to the Islands is by ferry which makes regular trips from Anacortes to Sidney, British Columbia, and carries passengers, vehicles and freight with stops at Lopez, Shaw, Orcas and Friday Harbor. Distance from the mainland to the nearest island is over 3 miles across the deep channel of Rosario Strait which precludes any likelihood of future bridging. About 250 miles of county and state highways traverse the four largest islands. Regular air service is available at Friday Harbor.

The mild climate of the islands is due to modifying westerly winds from the North Pacific Ocean. Summers are cool and dry and winters are mild and moist. The average annual precipitation ranges from about 20 to 29 inches.

The surfaces of the Islands are, in general, underlain by glacial drift through which numerous rocky knobs protrude. Shorelines are irregular, elevated and rocky. Low relief characterizes the glaciated part of the Islands with glacial plains and gently rolling and basin-like areas. There are only a few deeply entrenched drainways. Lopez Island has a larger proportion of level land than any of the larger islands. There are 15 peaks on the Islands that exceed 1,000 feet. The highest, Mt. Constitution on Orcas Island, is 2,409 feet.

Land use on the Islands is shown below:

| | Acres |
|---|---|
| Cropland | 19,000 |
| Rangeland | 9,000 |
| Forest | 72,000 |
| Rural nonagricultural | 9,000 |
| Built-up areas | 3,000 |
| Total | 112,000 |

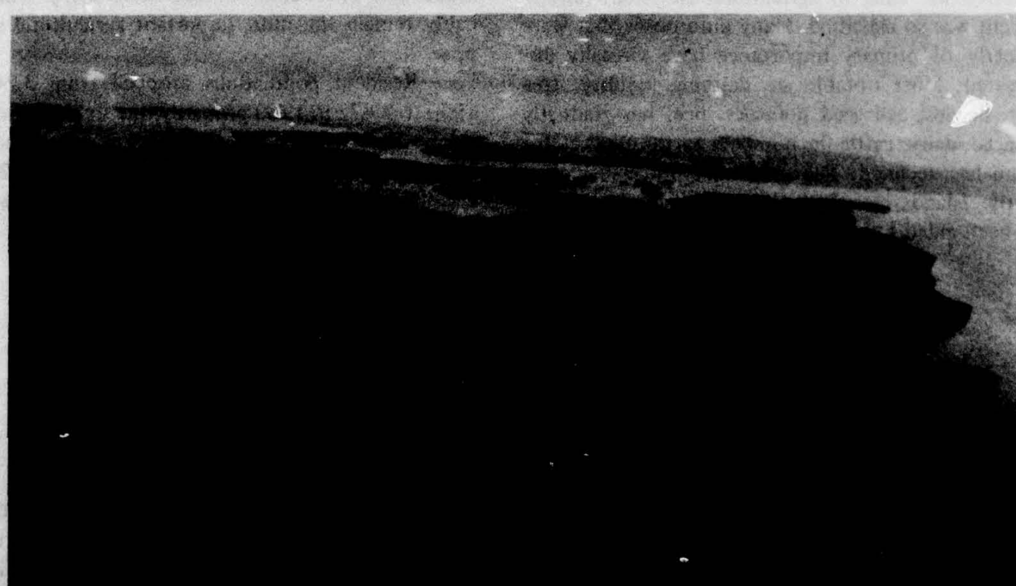


PHOTO 13-1. Orcas Island looking south toward San Juan Island. (USBR photo)

PHOTO 13-2. Shaw and Lopez Islands. (USBR photo)

The major portion of the Islands is in private ownership with the exception of 3,500 acres of State and 2,200 acres of Federal woodland.

The decline in agriculture from its peak in 1925 is evident from recent employment statistics. In 1940, 34 percent of the work force in the county was classified as being in agriculture. In 1960, only 7 percent was so classified. Many enterprises that were formerly of primary importance have virtually disappeared. Most notable are dairying, poultry, tree fruit, berries, and seed potatoes. Beef has gradually replaced dairy cattle in numbers as the market for cream has declined. The only milk processing plant on the Islands closed in 1963. Agricultural activity has been aided in recent years by hobby farmers and retired persons moving to the Islands. Subdividing farms for rural residences is an active enterprise, particularly waterfront and view property. Some conversion of farms to recreation endeavors has taken place. These include three golf courses, one shooting preserve, hunting camps, recreation camps, and riding academies. Production of beef and sheep will probably remain the most important agricultural enterprise.

Resident populations dropped from 3,245 in 1950 to 2,872 in 1960 primarily due to closure of the Roche Harbor Lime and Cement Company plant. In 1967 the population was estimated to be 2,921, all classified as rural with both farm and non-farm people.

# PRESENT STATUS

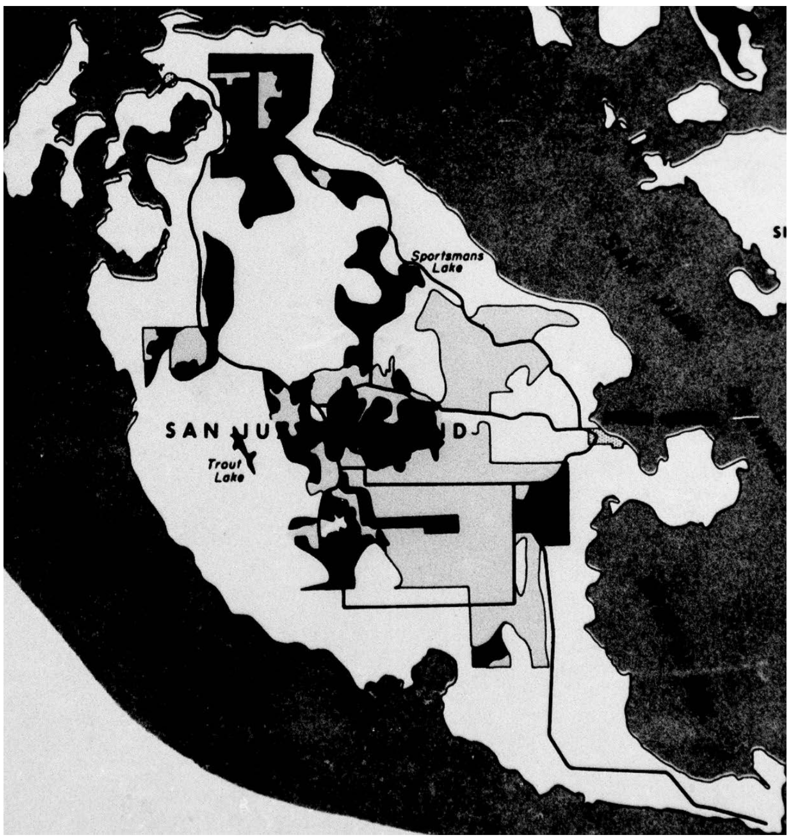
## IRRIGATED LANDS

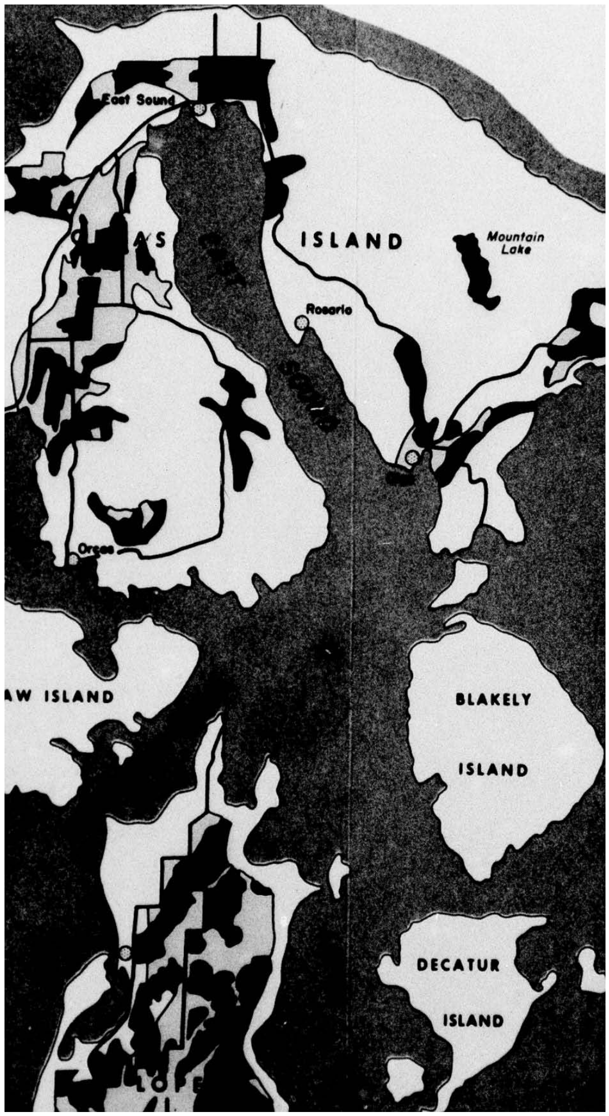
There has been little irrigation development on the San Juan Islands. It is expected that there will be no significant increase in irrigation in the future. It is estimated that about 100 acres are irrigated on San Juan Island. All of the irrigated lands are in pasture and forage crops. Presently irrigated lands and potentially irrigable lands are shown on Figure 13-1.

## WATER RESOURCE

### Water Supply

The San Juan Islands have few significant streams. The watersheds are small and streamflow is intermittent. Only a few of the larger islands are of sufficient size to support well-defined perennial stream systems. Several small lakes and reservoirs are


Sportsmans Lake
SAN JU
ND
Trout Lake


East Sound
ISLAND
Mountain Lake
Rosario
Orcas
ISLAND
BLAKELY
ISLAND
DECATUR
ISLAND

used for municipal and industrial and irrigation purposes.

Ground water is also limited in availability. The well yields rarely exceed 20 gallons per minute; the largest yield recorded in the Islands is 50 gallons per minute. Deeper wells drilled into older consolidated rocks are usually not capable of furnishing more than 10 gallons per minute.

The water obtainable is of sufficient quality for most uses. Generally, better quality water is found in deeper aquifers than in the shallower aquifers.

### Water Rights

Approximately 40 surface water permits and certificates are recorded for nearly 10 cubic feet per second as of April 30, 1967. About 50 ground water permits and certificates are recorded for the appropriation of 3 cubic feet per second as of September 30, 1966.

Up to 5 cubic feet per second can be diverted from surface sources for the irrigation of about 500 acres. Irrigation ground water rights are for less than 100 acres. Many of the irrigation rights are for very small acreages.

### Adequacy of Supply

The lands that are presently served (100 acres) are adequately supplied. Low runoff volumes and lack of natural holding basins preclude the likelihood of significant storage projects in the future. Irrigation use of water on the Islands is small and is not expected to increase.

## IRRIGATION ECONOMY

### Summary of Irrigation Values

The present value of irrigation is the incremental gross income value of increased livestock production attributable to irrigation in average year. This value is $3,000.

Other values from irrigation that accrue to the farmer and to other sectors of the local economy are discussed briefly in the section of this appendix covering The Puget Sound Area.

### Basic Data

Agricultural Census data for 1964 and field survey information have been used as a basis for estimating cropping patterns, farm types and sizes, numbers of farms, value of farm products sold, livestock numbers, and production, and value of livestock products. Adjustments to census data are explained in detail in the section of this appendix which discusses The Puget Sound Area.

### Number, Type, and Size of Farms

There are about 160 farms on the San Juan Islands, one of which had irrigated cropland in 1964. Field observations in 1967 disclosed two farms having

PHOTO 13-3. Orcas Island looking towards San Juan Island. (USBR photo)

irrigation facilities. As shown in Table 13-1, dairy and other livestock farms are the most common farming enterprises on the Islands.

**TABLE 13-1. Farm types–1964[1]**

| Type of Farm | Estimated Number on Islands[2] | Percent of Total |
|---|---|---|
| Field Crop | -- | -- |
| Vegetable | -- | -- |
| Fruit and Nuts | -- | -- |
| Poultry | 5 | 3.1 |
| Dairy | 5 | 3.1 |
| Other Livestock | 45 | 28.2 |
| General | 5 | 3.1 |
| Miscellaneous | 100 | 62.5 |
| Total | 160 | 100.0 |

[1]Estimated from Census of Agriculture.
[2]Rounded to the nearest 5.

Both of the farms with irrigation facilities are beef cattle operations. One farm has an estimated 400 acres of cropland, the other has between 200 and 300 acres. All of the cropland irrigated is in forage crops.

## Crops

Total crop production related to irrigation use is shown in Table 13-2.

**TABLE 13-2. Estimated land use and crop production related to irrigation**

| Major Crop Group | Acres Normally Irrigated | Unit of Yield | Increased Production Related to Irrigation: Per Acre | Total[1] |
|---|---|---|---|---|
| Forages | | | | |
| Hay | 30 | Ton | 2.00 | 60 |
| Pasture | 70 | AUM | 4.76 | 330 |

[1]Rounded to the nearest 10.

## Livestock

Limited markets for perishable products on the Islands and their isolated location have made livestock operations the major farming enterprise. Livestock products are processed and marketed on the mainland. The derivation of estimated animal units of feed requirements and production is shown in Table 13-3.

**TABLE 13-3. Estimated feed requirements and production**

| Item | Animal Units Required Per Head | Number of Head[1] | Total Animal Unit Requirement |
|---|---|---|---|
| Dairy Cattle | | | |
| Per Cow | -- | -- | -- |
| Per Feeder | -- | -- | -- |
| Beef Cattle | | | |
| Per Cow | 1.27[2] | 1,780 | 2,261 |
| Per Feeder | .38 | 260 | 99 |
| Total | | | 2,360 |
| Rounded | | | 2,360 |

| Item | Animal Amount Produced | Total Unit Equivalents[3] | Animal Units Production |
|---|---|---|---|
| Forage | | | |
| Hay-Ton | 60 | .20 | 12 |
| Pasture-AUM | 330 | .08 | 26 |
| Small Grains-Ton | -- | -- | -- |
| Corn Silage-Ton | -- | -- | -- |
| Total | | | 38 |
| Rounded | | | 40 |

[1]Rounded to the nearest 10 head.
[2]Includes feed required for replacements, bulls and young stock normally associated with the breeding herd.
[3]Animal Units of feed per ton/AUM.

The increased production from irrigated cropland used to produce forage in support of livestock enterprises provides about 1.7 percent of the total feed required in the Islands. This relationship is used to determine the proportion of total livestock production attributable to irrigation.

The estimated production of livestock and livestock products related to irrigation based on total digestible nutrient (TDN) requirements, is shown in Table 13-4. The production is based on 1.7 percent of the feed requirements being supplied by irrigated forages and grains as derived in Table 13-3.

In terms of T.D.N.'s only, the full feed requirements of about 80 head of cattle and calves could be met with the increased production of feeds from irrigation. However, few cattle are raised entirely on irrigated feed. In reality, the nutritional requirements of more than 80 head of cattle are partially satisfied by irrigated feeds.

**TABLE 13-4. Estimated production of livestock and livestock products related to irrigation**

| Item | Number or Amount Sold | Number on Hand | Total | Percent Related to Irrigation | Production Related to Irrigation [1] |
|---|---|---|---|---|---|
| Cattle and Calves | 1,520 head | 3,410 head | 4,930 head | 1.7 | 80 head |

[1] Livestock rounded to the nearest 10 head, livestock products rounded to the nearest 100 lbs.

**TABLE 13-5. Estimated livestock and livestock product values related to irrigation**

| Item | Value of Sales (dollars) | Adjustment Factor[1] | Adjusted Value of Sales (dollars) | Percent Related to Irrigation | Value Related to Irrigation[2] (dollars) |
|---|---|---|---|---|---|
| Cattle and Calves | 176,800 | 1.051 | 185,817 | 1.7 | 3,200 |
| Rounded | | | | | 3,000 |

[1] Prices received—Livestock and Livestock products. $\frac{\text{Long-term adjusted normalized index}}{\text{1964 index}} = \frac{247}{235} = 1.051$

[2] Rounded.

## Livestock and Livestock Product Values

Estimated livestock and livestock product values related to irrigation are shown in Table 13-5. The value estimates are based on the proportion of feed attributable to irrigation.

# FUTURE NEEDS

## IRRIGATION POTENTIAL

Arable lands on the San Juan Islands total 25,500 acres, of which about 100 acres are presently irrigated and 25,400 acres are potentially irrigable. The lands are located on glacial till plains and basins.

### Land Characteristics

Soils have developed under the influence of summers that are cool and dry and winters that are mild and moist. They have formed on glacial till and drift. Surface textures range from coarse to medium and subsoils and substratum range from loose and porous to dense, very slowly permeable till.

The upland soils are used mainly for production of pasture and hay crops and the lower lying basin lands could be used for production of cash crops. In general the soils are low in natural fertility and they respond well to fertilizers.

In general, the potentially irrigable lands are well adapted to sprinkler irrigation. The topography of the basins and lower lying glacial plains is generally nearly level to gently sloping and the higher lying uplands are predominantly gently rolling to rolling. They are well suited to agricultural development.

### Land Classes

Potentially irrigable lands on the San Juan Islands total about 25,400 acres, of which about three-fourths are presently in woodlands. No detailed classification was done because it is expected that future irrigation development will be negligible. Potentially irrigable lands are shown on Figure 13-1.

## PROJECTION OF FUTURE IRRIGATION

Due to the lack of adequate water supplies, significant irrigation development on the Islands is not anticipated.

# MEANS TO SATISFY NEEDS

The small-scale irrigation development that could occur on the Islands in the future will most likely be by private means. The costs of developing individual farm sprinkler systems are outlined in The Puget Sound Area under Means to Satisfy Needs.

Based on present day values, cropping patterns, and levels of production, the additional annual gross income that would accrue to the farmer for irrigating new, potentially-irrigable lands would amount to approximately $30 per acre.

The State and Federal agencies with responsibilities for constructing and/or supplying local assistance for developing an irrigation system are discussed in The Puget Sound Area under Means to Satisfy Needs.